

# Arguments for the Liquid Hydrogen Target

Rajendran Raja  
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## ***MIPP Physics Potential***

When we proposed MIPP, one of the main aims of MIPP was to restart the study of non-perturbative QCD reactions. All presently existing theories fail to explain over 99% of the total HEP cross section. MIPP provides a hitherto unavailable scientific opportunity to remedy this, in that it provides in one apparatus tagged beams of  $\pi^\pm, K^\pm, p^\pm$  particles, with final state charged particles being measured and identified over most of phase space. MIPP has in addition, some limited neutron and photon measuring ability in the forward region. MIPP, further provides high statistics, orders of magnitude more than available to previous experiments. MIPP's physics potential is thus greater than the combined potential of all open geometry experiments to study minimum bias reactions done to date. What we proposed before the PAC was to acquire the data and make it available as DST's to the "public" so that it will stimulate the development of new theories of these reactions.

Any new theory of these phenomena must confront exclusive reactions. By exclusive reactions, I mean reactions where the identity of all particles in the final state are known. Only with exclusive reactions, can we get a handle on angular distributions, correlations and exchanged entities in a straightforward fashion and proceed to build and test models.. The one reaction I mentioned during my talk ( $pp \rightarrow pp\pi^+\pi^-$ ) is but one example of this. This reaction will help study "pomeron" exchange in single diffraction. If, as a result of MIPP data, a better understanding of the pomeron emerges, then this reaction as well as other exclusive reactions will be crucial to this realization. If you search the reaction database, there are a large number of exclusive reactions studied. They all have poorer statistics than we will have and poorer particle identification . I list a few of them.

$\mathbf{p}^+ p \rightarrow A_1(1270) p$  Resonance production and diffraction  
 $\mathbf{p}^+ p \rightarrow K^+ \Sigma^+$  Strangeness s production  
 $K^+ p \rightarrow p p \bar{\Lambda}$  strangeness s and Baryon number production  
 $K^+ p \rightarrow \Delta^+ K^0 p^+$  charge exchange and resonance production  
 $p^+ p \rightarrow p p K^+ K^-$  Diffraction , strangeness s production  
 $p^+ p \rightarrow p p p^+ p^-$  Diffractive Dissociation, Pomerons  
 $\mathbf{p}^- p \rightarrow p^0 n$  Classic  $r$  exchange reaction  
 $\mathbf{p}^- p \rightarrow K^0_*(892) \Lambda$  Strangeness s resonance production  
 $K^- p \rightarrow K_3^*(1780) p$  Exotic resonance production  
 $K^- p \rightarrow p K^-$  Strange Baryon exchange  
 $p^- p \rightarrow 3p^+ 3p^-$  Annihilation  
 $p^- p \rightarrow p \bar{n} p^-$   $\bar{p}$  diffraction (4C if we detect  $\bar{n}$ , else 1C)

In Appendices A-F, I have made a nearly exhaustive list of exclusive reactions for the 6 beam species that are taken from the HEPDATA database. MIPP data, using liquid Hydrogen target will be relevant to all these exclusive channels for anyone wishing to test his newly developed theory of non-perturbative QCD.

### Kinematic fitting

The way one ensures that all the final state particles are known is by kinematic fitting. In the past, one assigned errors to all the initial and final state momenta, made a hypothesis for the identity all the detected particles and fitted for the momenta. Programs such as SQUAW were written to do this. In MIPP's case, the apparatus will tell us the identity of the final charged particles, so it will reduce the combinatorics in the fit. In the case where the incoming beam is known, this is a 4 constraint (4C) fit. If it fits, then one can assume that there are no missing neutrals in the final state (most common missing neutral is  $\pi^0$ ). The fundamental assumption is that the identity of the target particle is known. In the case of liquid hydrogen, this is the proton. If deuterium is used, one is not sure whether the target is a neutron or a proton, so kinematic fitting becomes more complicated. The presence of Fermi motion of the nucleon complicates matters further. This is the main reason why liquid hydrogen bubble chambers had a field day and Alvarez won the Nobel prize. As you go to larger nuclei, such as Carbon, kinematic fitting becomes impossible, due to the presence of many target fragments (neutrons and protons).

If one has a liquid hydrogen target, one can also do physics, where there is one missing neutral such as a  $\pi^0$  or a missed neutron, since it still results in a one constraint (1C) fit. Examples of these reactions are ( $pp \rightarrow pp\pi^0$  and  $pp \rightarrow p n \pi^+$ ) both of which are diffraction processes. In the case of glueball searches, MIPP data with liquid hydrogen is not only sensitive to glueballs that decay into all charged particles but also to glueballs that decay

into charged particles and a missing neutral. Similar reasoning holds for pentaquark states. Liquid hydrogen data thus is crucial to realizing MIPP's physics potential.

## **Subtraction using CH2-C**

If one acquires hydrogen data by subtracting C data from CH2 data, (assuming no systematics), one essentially gives up the study of all exclusive reactions in the final state, since one does not know if the nucleus is carbon or hydrogen on an event-by-event basis. *The discussion on whether we need a liquid hydrogen target should end with this realization.* In what follows, I will buttress the need for the LH2 target using other considerations, in other data channels, (some of which have been touched on by Ed Hartouni), using independent reasoning to the one given above.

## ***Shower Monte Carlo programs***

Some of the customers for MIPP data are the shower Monte Carlo programs such as GEANT4 and MARS, as well as the cosmic ray shower Monte Carlo programs. The quality of the data used by these programs is poor, with systematic errors in the data running as large as 30%. In addition to extrapolating between nuclei to simulate collisions of interest, these programs also have to generate the events at these collisions by Monte Carlo (they use the measured cross sections and multiplicities to do their event generation by random numbers). Events thus generated do not adequately simulate particle production correlations and kinematics. A way around this is to use actual MIPP events in a database, scaled to the appropriate center of mass energy as part of the Monte Carlo. Ed Hartouni and I discussed this possibility long ago, as we proposed MIPP. Subtraction schemes will void this possibility. These considerations argue for nitrogen data to come from liquid nitrogen (for atmospheric neutrinos) and oxygen data to come from liquid oxygen (Fermilab safety permitting!).

## ***Evaluating the MIPP offline reconstruction and trigger efficiencies***

As we get first data, we will need to understand our trigger and reconstruction efficiencies in a rapid fashion. The sooner we understand these, the quicker we will be able to debug MIPP to correct for possible bugs as well as get to publication rapidly. Liquid hydrogen data, taken early in the run will enable to do this rapidly. It will help in several areas. Multiplicity distributions and cross sections are known in a systematic free fashion from liquid hydrogen bubble chamber data. Comparing our findings to these will help debug our trigger and track finding efficiencies as a function of beam energy. Assuming no systematics in subtraction, we still would need to process twice as many events to get subtraction data with inferior statistics.

In order to find our particle ID efficiencies, as I pointed out during the collaboration meeting, pp data has a central role to play. It is symmetric in the forward and backward hemispheres in the center of mass. Backward hemisphere in the center of mass resides mostly in the TPC, the time of flight and the multi-cell Cerenkov and the forward mostly

in the RICH. The exact fractions of these will depend on the beam energy. If I were a referee of a MIPP paper, I would insist that MIPP pp data show these symmetry qualities as a function of beam energy and that it agrees in magnitude with published data for all  $p\bar{p} > 6$  final state particle species. The sooner we have this data, the better we would be in ensuring that the apparatus and algorithms are functioning well. We do not want to wait till after the data-taking is done to have these results. The argument against subtraction here is one of expediency and statistics. Again, we assume no systematics in subtraction. I include some distributions from the Physical Review by Jim Whitmore that are of relevance to MIPP.

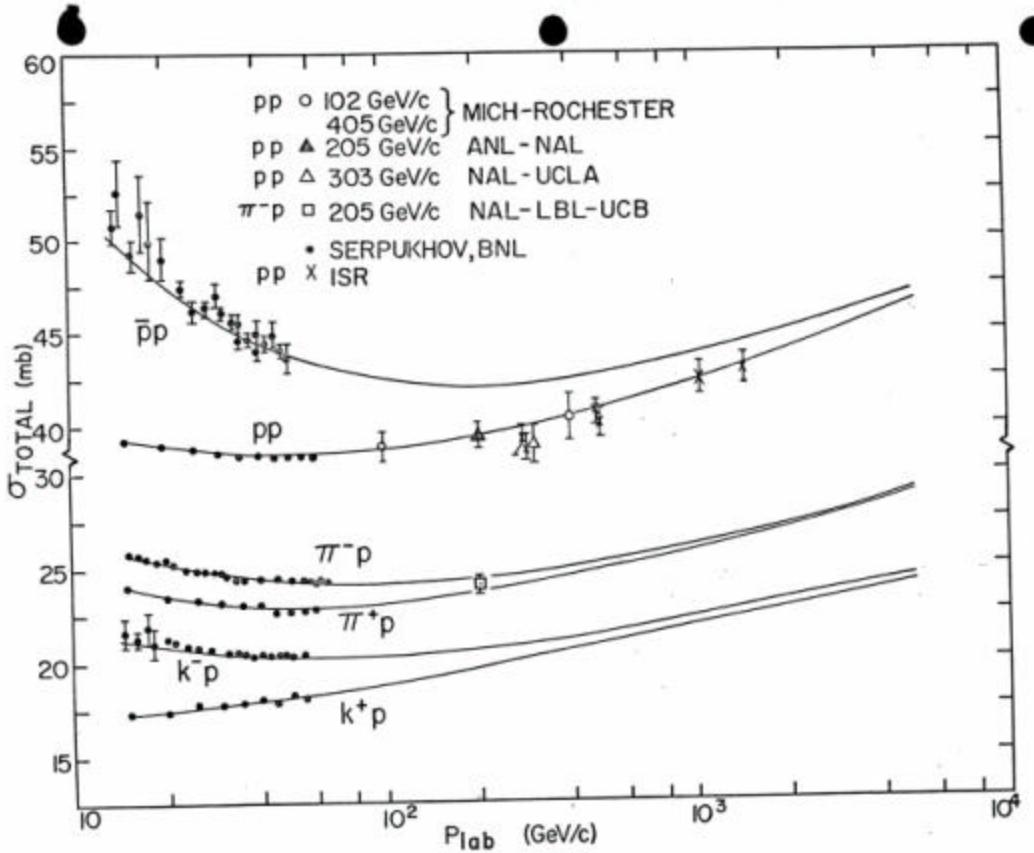


Fig. 7

**Figure 1** Total cross sections for the 6 beam species as a function of beam momentum

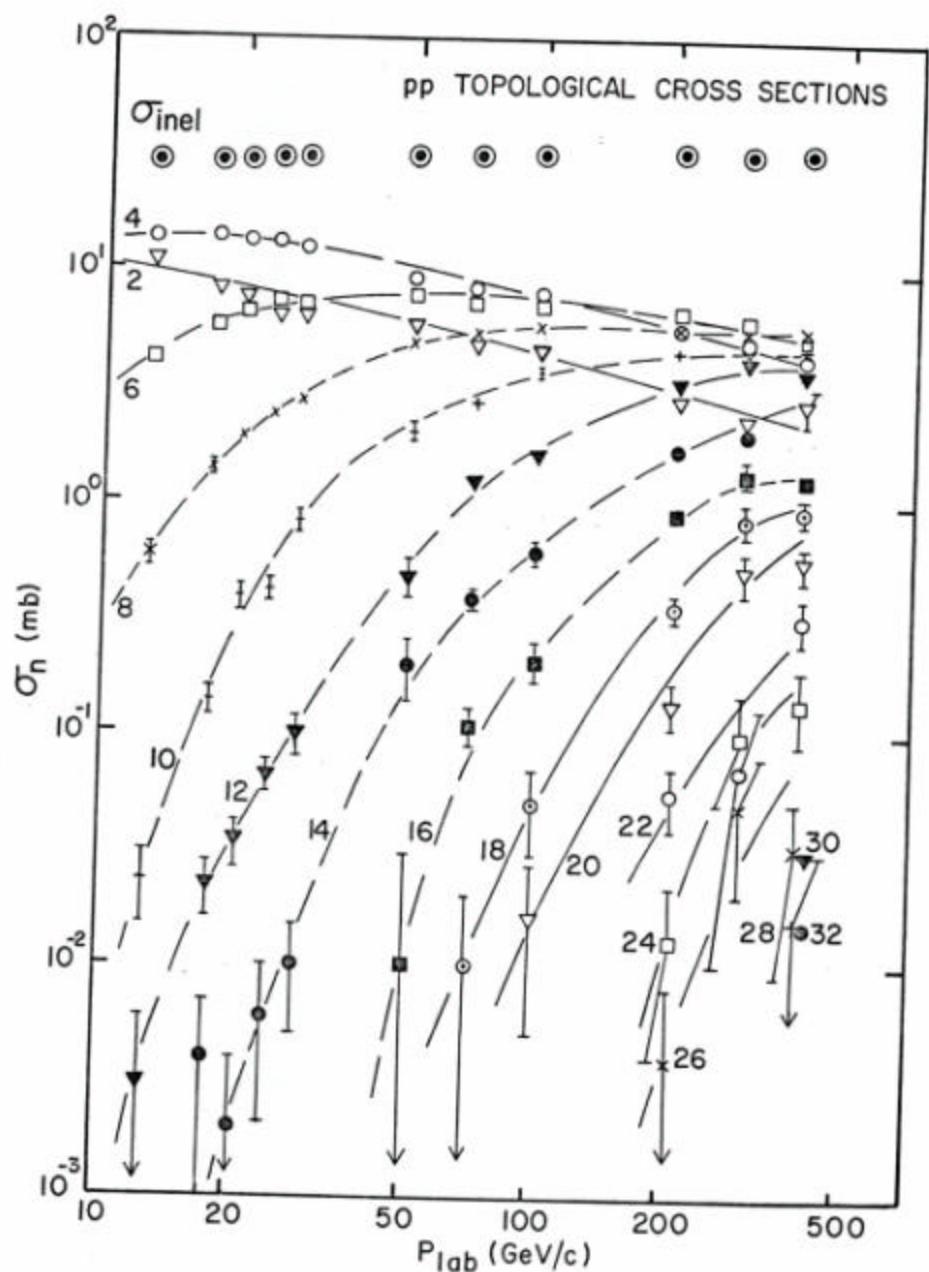


Fig. 8

Figure 2 pp topological cross sections as a function of beam momentum

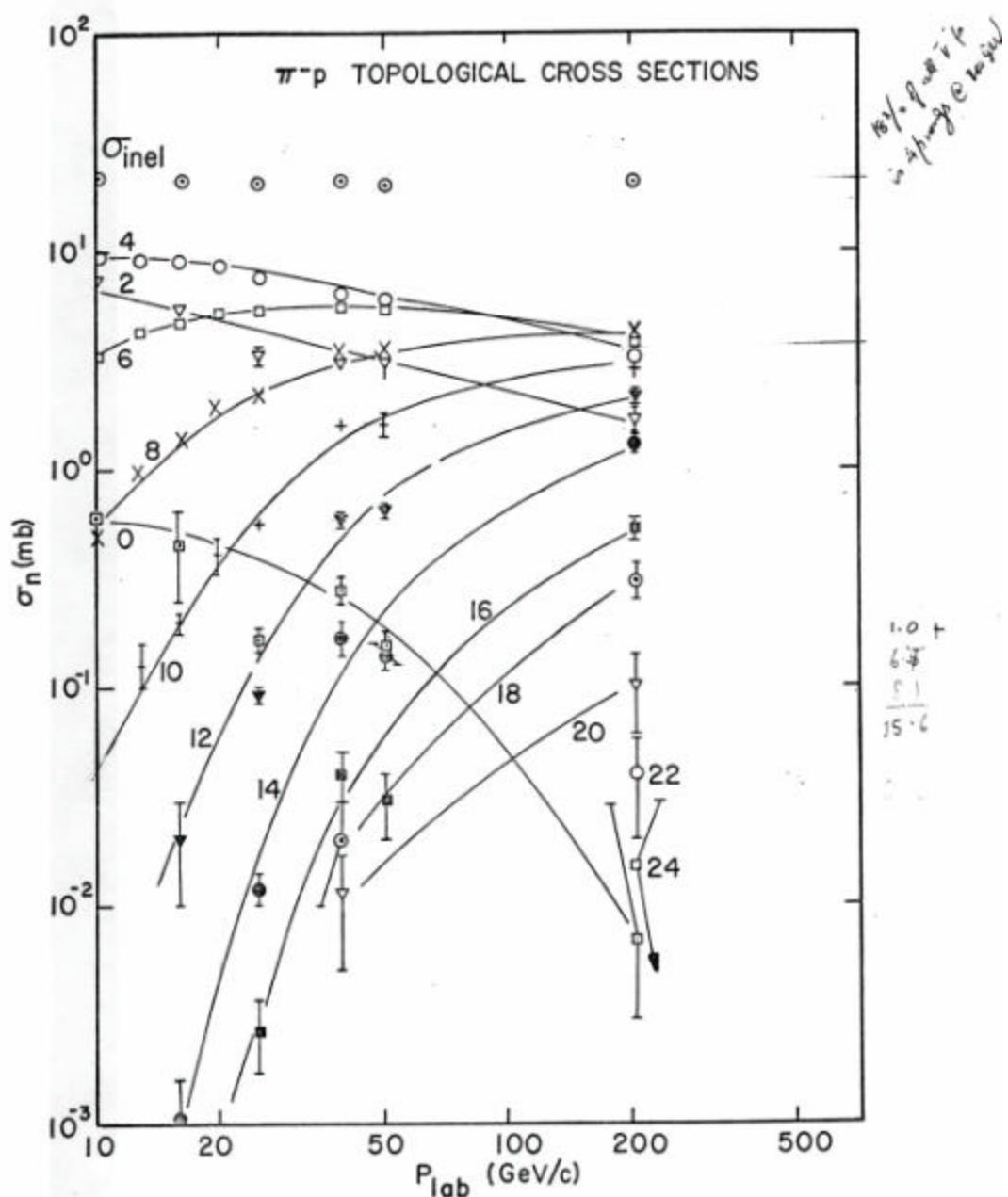


Fig. 9(a)

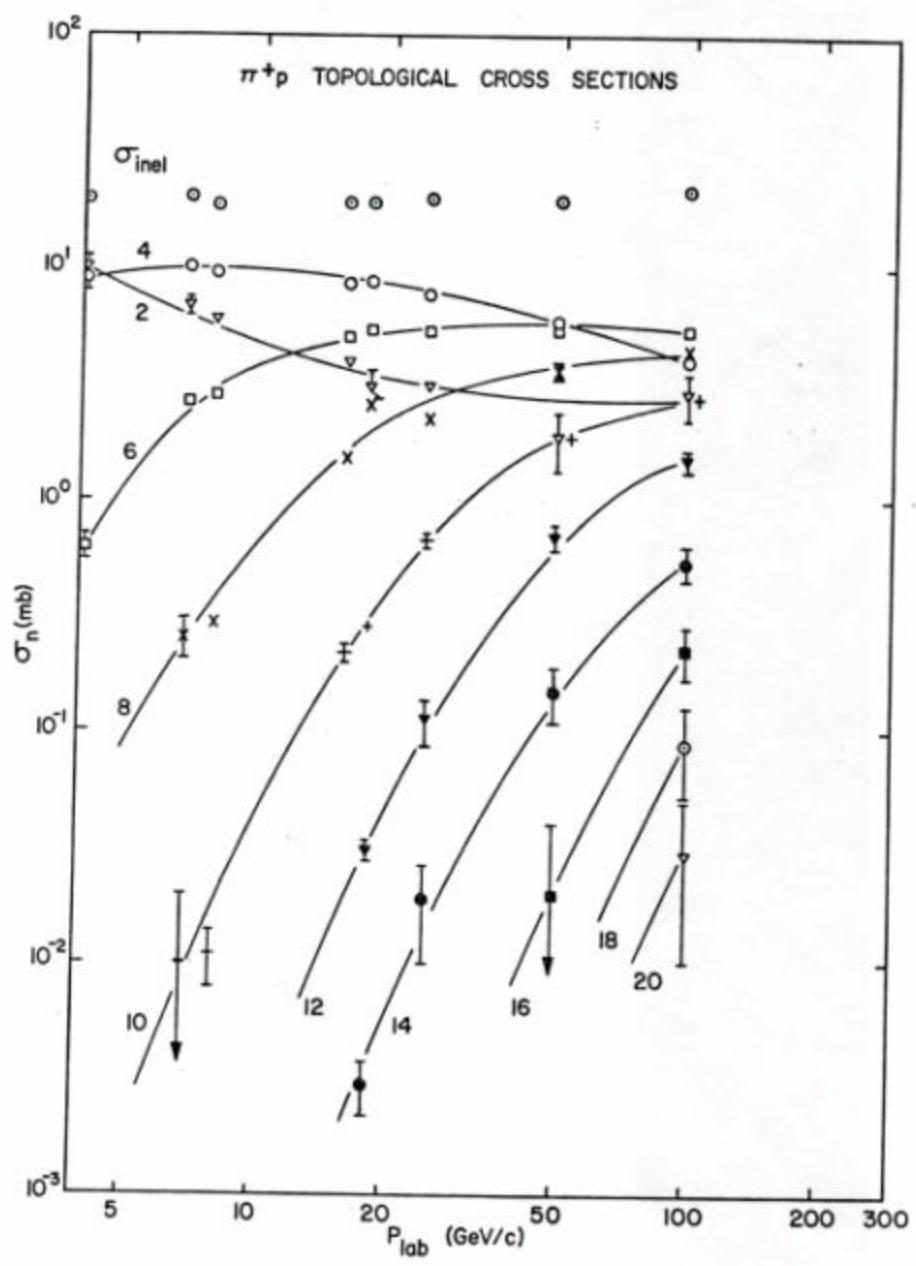


Fig. 9(b)

Figure 3  $p^+$  topological cross sections as a function of beam momentum

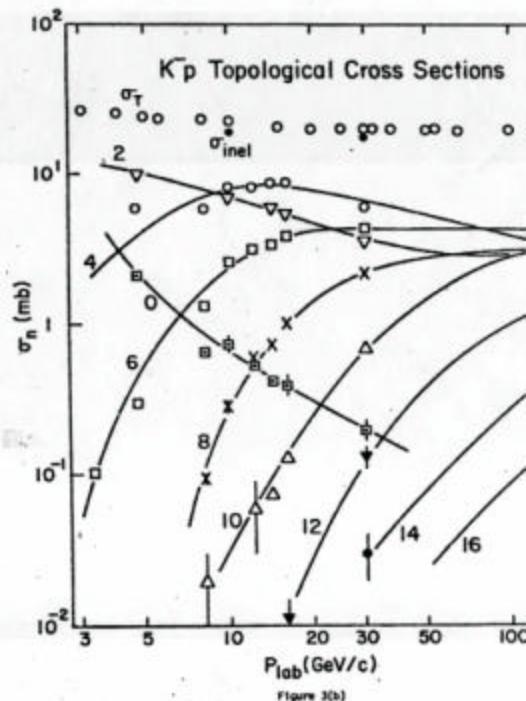
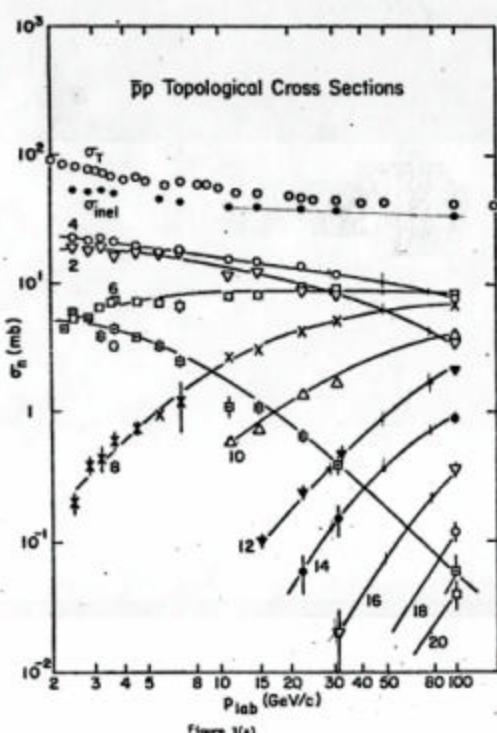


Figure 4 p<sup>-</sup> and K<sup>-</sup> topological cross sections as a function of beam momentum

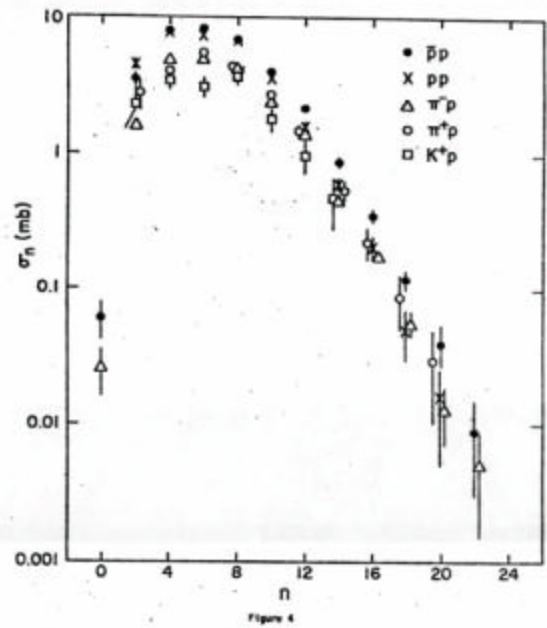
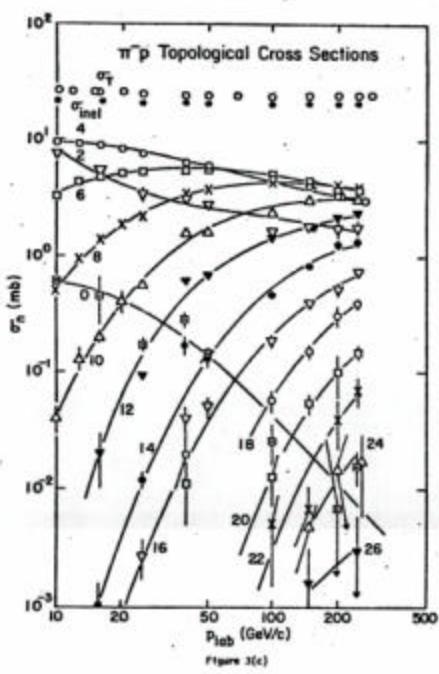


Figure 5  $p^-$  topological cross sections as a function of beam momentum (LHS)

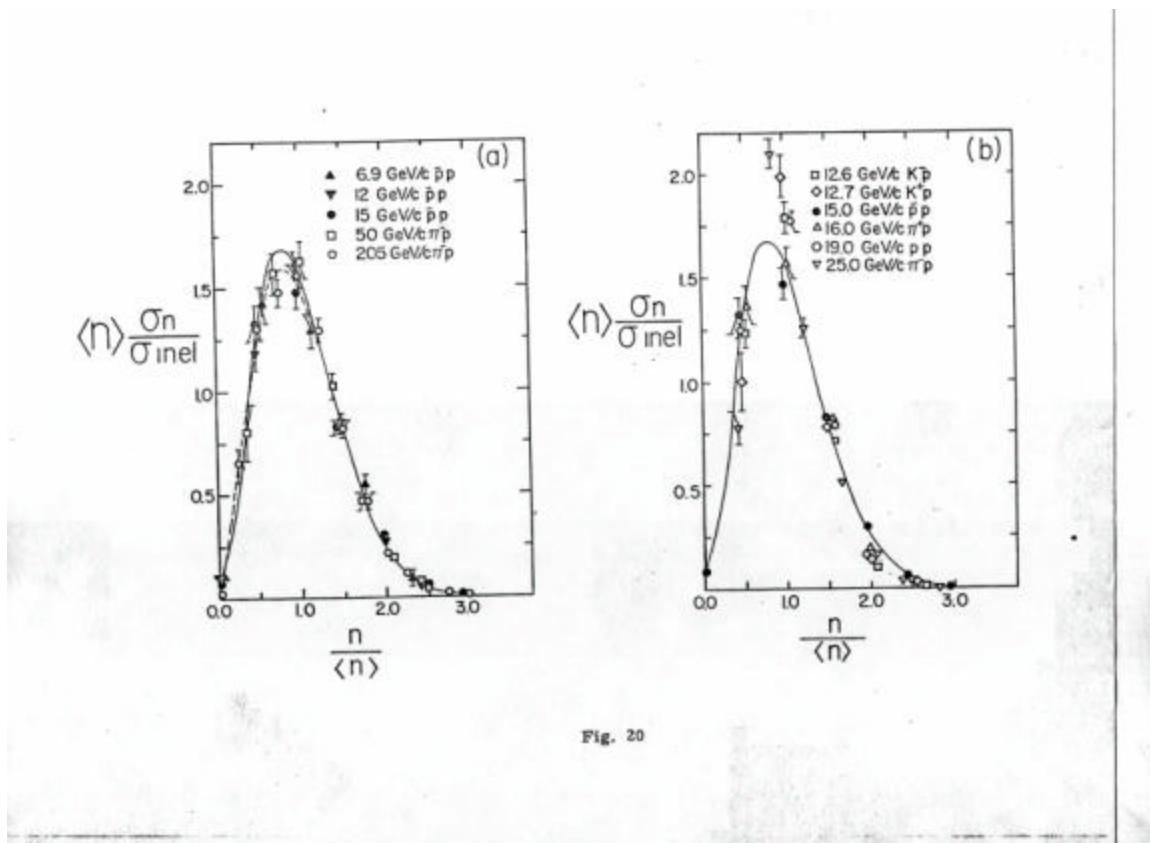


Figure 6 KNO scaling of multiplicities at our energies

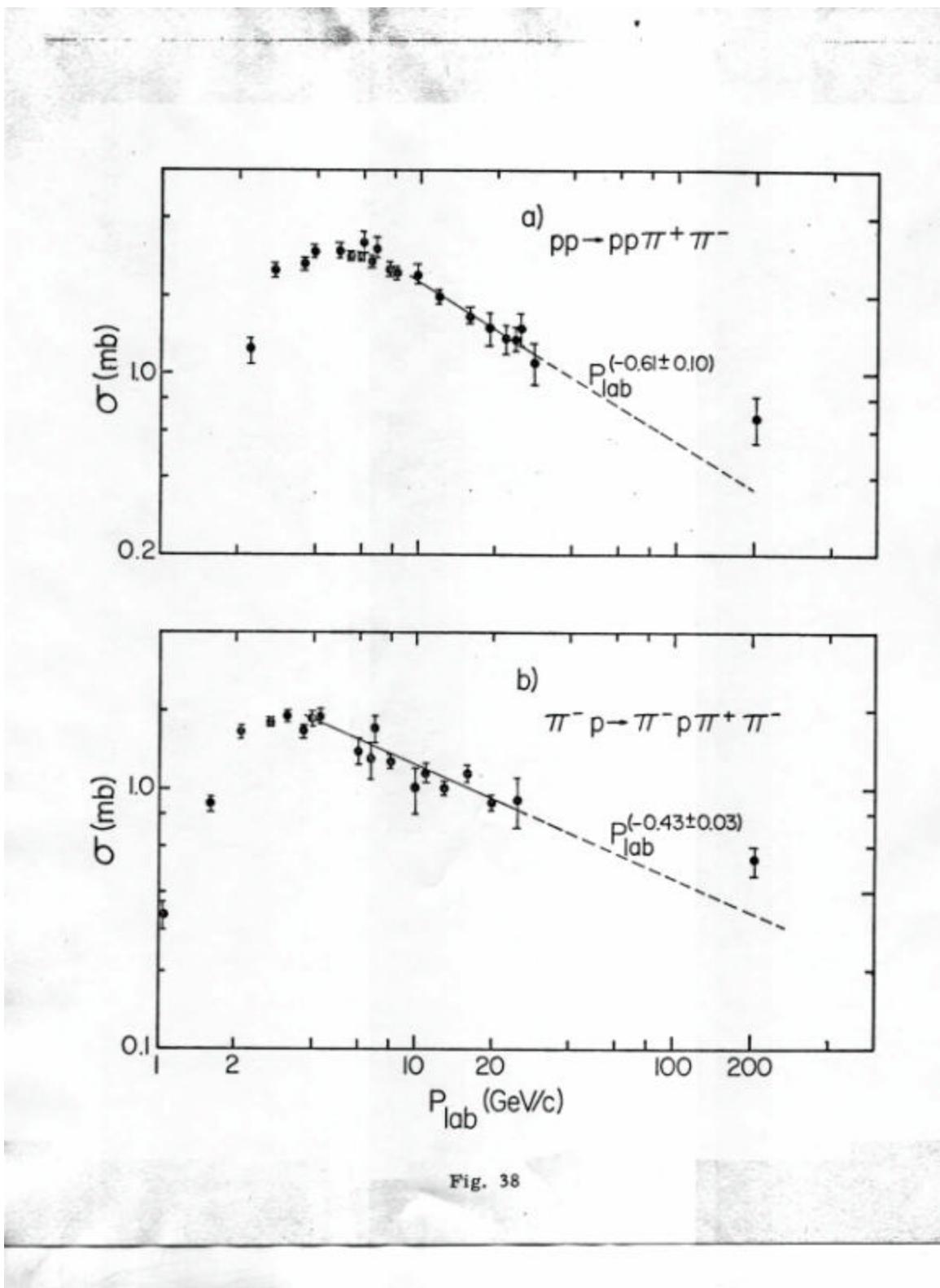


Fig. 38

Figure 7 Behavior of two exclusive diffractive dissociation reaction cross sections as a function of beam momentum

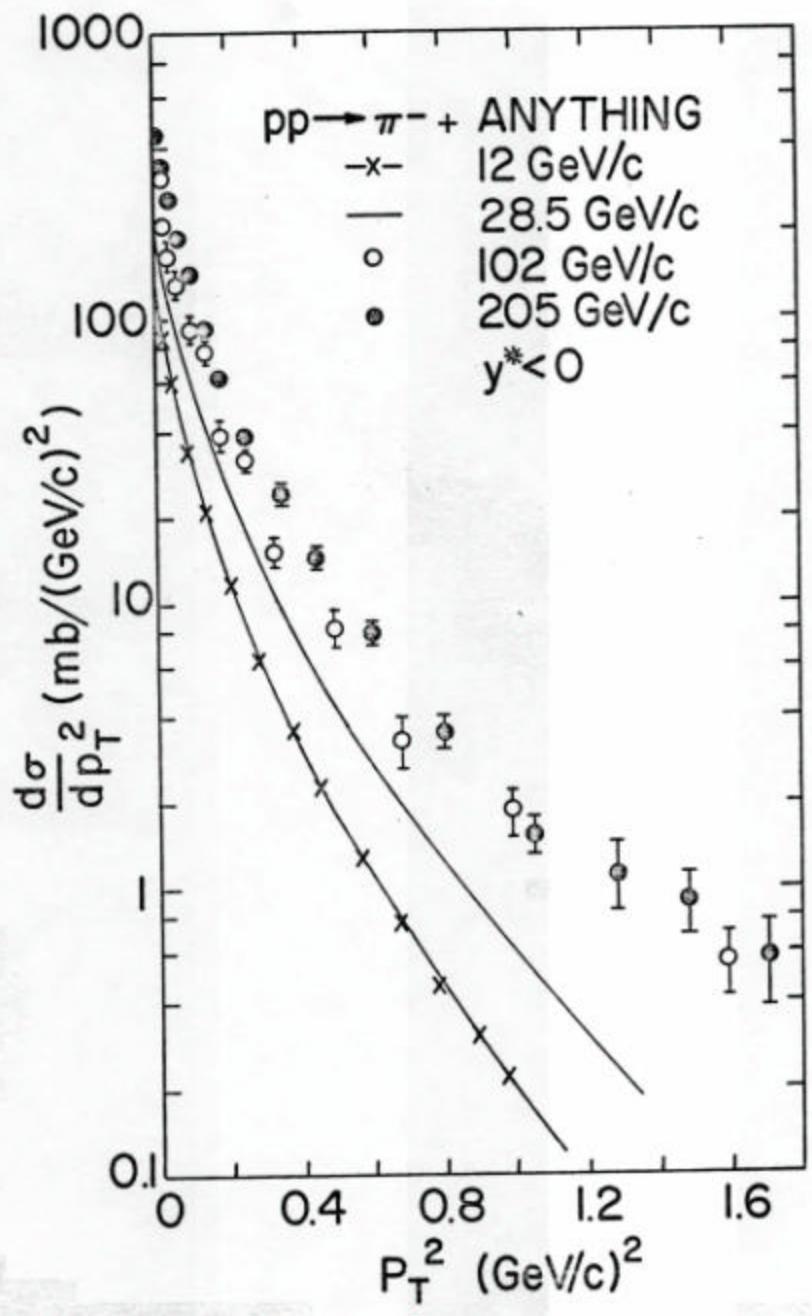


Fig. 60

Figure 8  $\text{pp} \rightarrow \pi^-$  inclusive cross section as a function of momentum. Only well measured tracks in the center of mass backward hemisphere tracks used since cross section is symmetric.

## Scaling Law tests

The scaling relations we want to test in inclusive reactions  $a+b \rightarrow c+X$  state that the ratio of a semi-inclusive reaction  $f_{\text{subset}}(M^2, s, t)$  to the overall inclusive reaction  $f(M^2, s, t)$  is a function of  $M^2$  only, where  $s$  is the center of mass energy squared,  $t$  the momentum transfer from particle  $a$  to particle  $c$ , and  $M^2$  is the missing mass squared of the system  $X$ .

$$\frac{f(a+b \rightarrow c+X_{\text{subset}})}{f(a+b \rightarrow c+X)} = \frac{f_{\text{subset}}(M^2, s, t)}{f(M^2, s, t)} = \beta_{\text{subset}}(M^2)$$

The physics behind this relation is understood in terms of three body scattering of  $a, b$  and  $c$  as taking place in two steps, the formation of a fireball  $X$ , which decays into a subset,  $\beta_{\text{subset}}(M^2)$  being the branching ratio of a pseudo-resonance like fireball into the subset. This branching ratio is independent of the method by which the fireball was formed (R.Raja, Phys Rev D 18 (1978) 204), so the ratio is only a function of  $M^2$ .



**Figure 9 Formation and decay of the three-body initial state fireball.**

For the beam particle  $a$ , there are six beam species  $\pi^+, K^+, p^+, \pi^-, K^-, p^-$ . These particles are numbered in what follows as 1,2,3,4,5 and 6. The target particle  $b$  has always to be a proton. For the particle  $c$ , there are also the same 6 possibilities. So, we can refer to a reaction  $a+b \rightarrow c+X$  by the numbers for  $a$  and  $c$ . e.g. the reaction  $K^+ p \rightarrow \pi^- + X$  as the reaction 24. For each reaction, there will be a set of functions  $\beta_n(M^2)$ . If we decide to examine the subsets defined by multiplicity. These functions  $\beta_n(M^2)$  will be similar to the multiplicity fractions plotted as a function of  $s$  (similar to Figure 3), except that they will be a function of  $M^2$ . One has to show that these functions are independent of  $s$  and  $t$  for 36 reactions. The reactions are shown in the following table.

**Table 1 Thirty six reactions for testing the scaling law .**

### Scaling Law Reactions

Beam	Outgoing Species	Crossed outgoing Species	Crossed Beam Species	Particle code
1	1	=	4	1 2
Species	Species	Species	Species	$p^+$ $K^+$
1	1	=	4	$p^+ + p$
				----->
				$p^+ +$

1	2	=	5	4	$p^+$	+	$p$	----->	$K^+$	+
1	3	=	6	4	$p^+$	+	$p$	----->	$p$	+
1	4	=	1	4	$p^+$	+	$p$	----->	$p^-$	+
1	5	=	2	4	$p^+$	+	$p$	----->	$K^-$	+
1	6	=	3	4	$p^+$	+	$p$	----->	$p^-$	+
2	1	=	4	5	$K^+$	+	$p$	----->	$p^+$	+
2	2	=	5	5	$K^+$	+	$p$	----->	$K^+$	+
2	3	=	6	5	$K^+$	+	$p$	----->	$p$	+
2	4	=	1	5	$K^+$	+	$p$	----->	$p^-$	+
2	5	=	2	5	$K^+$	+	$p$	----->	$K^-$	+
2	6	=	3	5	$K^+$	+	$p$	----->	$p^-$	+
3	1	=	4	6	$p$	+	$p$	----->	$p^+$	+
3	2	=	5	6	$p$	+	$p$	----->	$K^+$	+
3	3	=	6	6	$p$	+	$p$	----->	$p$	+
3	4	=	1	6	$p$	+	$p$	----->	$p^-$	+
3	5	=	2	6	$p$	+	$p$	----->	$K^-$	+
3	6	=	3	6	$p$	+	$p$	----->	$p^-$	+
4	1	=	4	1	$p^-$	+	$p$	----->	$p^+$	+
4	2	=	5	1	$p^-$	+	$p$	----->	$K^+$	+
4	3	=	6	1	$p^-$	+	$p$	----->	$p$	+
4	4	=	1	1	$p^-$	+	$p$	----->	$p^-$	+
4	5	=	2	1	$p^-$	+	$p$	----->	$K^-$	+
4	6	=	3	1	$p^-$	+	$p$	----->	$p^-$	+
5	1	=	4	2	$K^-$	+	$p$	----->	$p^+$	+
5	2	=	5	2	$K^-$	+	$p$	----->	$K^+$	+
5	3	=	6	2	$K^-$	+	$p$	----->	$p$	+
5	4	=	1	2	$K^-$	+	$p$	----->	$p^-$	+
5	5	=	2	2	$K^-$	+	$p$	----->	$K^-$	+
5	6	=	3	2	$K^-$	+	$p$	----->	$p^-$	+
6	1	=	4	3	$p^-$	+	$p$	----->	$p^+$	+
6	2	=	5	3	$p^-$	+	$p$	----->	$K^+$	+
6	3	=	6	3	$p^-$	+	$p$	----->	$p$	+
6	4	=	1	3	$p^-$	+	$p$	----->	$p^-$	+



There are 36 reactions. Each initial state can be connected to another by crossing symmetry. Of the 36, 6 They are marked with X.

There remain 30 reactions. So there are 15 different crossing symmetry relations to be verified.  
Since 66=33 is duplicate of 33=66 for example.

These are

$$11=44$$

$$12=54$$

$$13=64$$

$$15=24$$

$$16=34$$

$$21=45$$

$$22=55$$

$$23=65$$

$$26=35$$

$$31=46$$

$$32=56$$

$$33=66$$

$$42=51$$

$$43=61$$

$$53=62$$

### C Symmetry relations

In additions to the 15 crossing symmetry relations, there exist relations due to C symmetry  
All targets have to protons

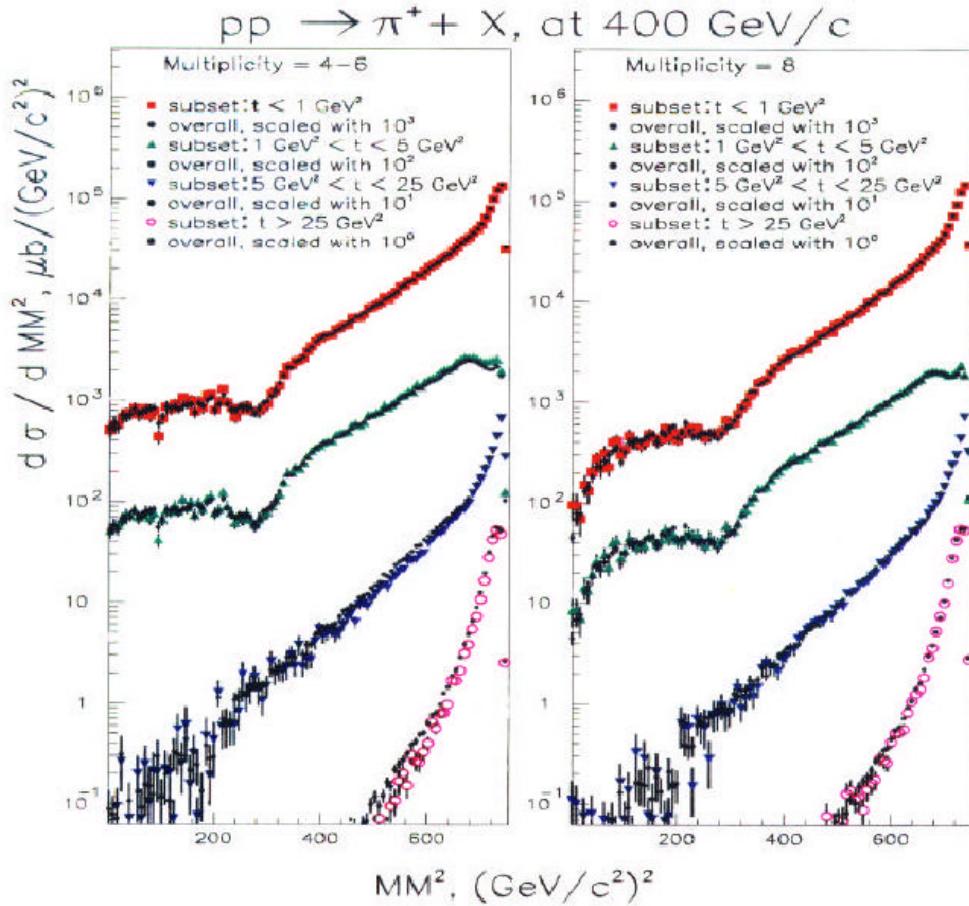
$$61=64=13=43$$

$$62=65=53=23$$

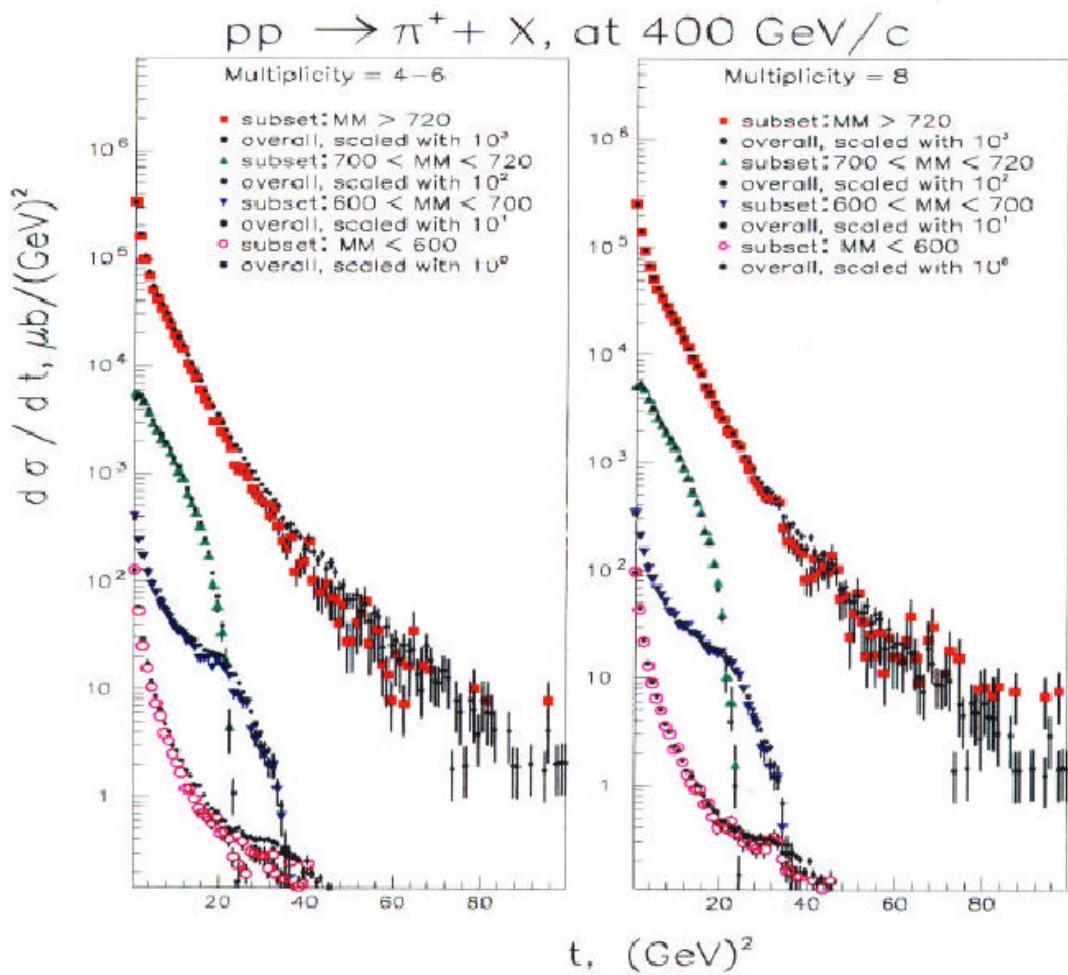
$$63=66=33$$

The functions  $\beta_n(M^2)$  in all these reactions are not independent. There are 15 reactions that are connected to other 15 reactions by crossing symmetry, where the  $\beta_n(M^2)$  will be the same. These relations are given (numerically) in the table above. E.g. 13=64 means that the  $\beta_n(M^2)$  will be the same for the reactions  $\pi^+p \rightarrow p + X$  and  $p^-p \rightarrow \pi^- + X$ . The first is a diffractive reaction and the second is a central production reaction. In addition, there are also 3 sets of equalities due to C symmetry which are also listed in the table. The process of verifying the scaling relations in 36 reactions becomes enormously complicated if one has to find the inclusive cross sections by subtraction, since (assuming no systematics), one immediately doubles the number of channels to 72!.

The way  $t$  independence is shown is to plot the overall cross section weighted by the appropriate  $\beta_n(M^2)$  superimposed as a function of  $t$  and  $M^2$ . This tests the scaling relation in all of phase space, where the cross section varies by orders of magnitude.



**Figure 10 Test of scaling law using EHS data ( $t$  independence as a function of  $M^2$ )**



**Figure 11 Test of scaling law using EHS data,  $t$  distribution for various M2 bins**

So the argument against using subtraction here hinges on the following observations

- One doubles the number of channels to analyze and understand for each beam energy from 36 to 72.
- Subtraction introduces fractional statistical errors that vary as a function of phase space due to the fact the differential Carbon cross section scales with  $A^n$ , with  $n$  varying from  $1/3$  to  $2/3$  to  $1$  as a function of phase space.
- We are trying to establish a fundamental new behavior of particles. If a violation is observed, one is never sure whether it is due to a systematic that was not thought of.. Similarly, if agreement is observed, skeptics would argue that it could be due to canceling effects from hydrogen and Carbon data! This is almost a catch 22 with subtraction. We need to be as clean as possible when claiming a new effect.

## **Systematics and Statistics of subtraction**

In order to fully examine the systematics of the subtraction scheme, one would need to get data. I agree with Mike Longo that one would need the events to investigate the efficacy of subtraction. We can however, make some calculations on the hit in statistical accuracy one takes, due to the subtraction scheme. The differential cross section in Carbon scales as a function of  $A^n$  where the exponent n varies as a function of phase space. We evaluate the statistical error in the subtraction method as a function of n, as well as the fraction of events that will have secondary scatters . We consider a CH<sub>2</sub> target that has a 1% interaction length for pions, for the sake of argument.

**Table 2 Increase in statistical error in H2 data due to subtraction, as a function of the exponent n**

	n=1	n=0.667	n=0.333
H2 interaction length	0.001429	0.002745	0.004683
Carbon interaction length	0.008571	0.007255	0.005317
Relative Statistical Error	9.899495	5.151328	3.01973

In areas where the Carbon cross section scales as A, the hydrogen data has 9.89 times the statistical error than one would get by direct running. This decreases to three times the statistical error for  $A^{0.33}$ .

When the multiplicity of the event is high, the probability of multiple interactions increases. Because we are diluting the hydrogen with carbon, we get probabilities of having secondary interactions in an event that are comparable to the probability that the event is on hydrogen.

**Table 3 Ratio of Probability of a secondary interaction in event /probability that the event is a H2 event vs n as a function of multiplicity**

Multiplicity	n=1	n=0.667	n=0.333
4	0.14	0.07	0.04
6	0.21	0.11	0.06
8	0.28	0.14	0.08
10	0.35	0.18	0.10
20	0.7	0.36	0.21

Table 3 plots the probability of a secondary interaction in the event as a function of the exponent n . For example, for n=1, the ratio of the probability that there is a secondary interaction in an event to that the event is H2 induced is 70%.

## **Potential Sources of systematics**

We list potential sources of systematics in the subtraction scheme. We are not stating that these systematics cannot be controlled, but that we would need to control them.

Potential sources of systematics in subtractions are

- Beam on CH<sub>2</sub> and C do not have same energy, energy spread, live time. These effects can be controlled by rotating targets. The differential cross sections in Carbon and H<sub>2</sub> have energy dependence that varies with phase space, so differences in beam energy and spread in CH<sub>2</sub> and C the beam energy can induce systematics.

- Average density and thickness of targets not fully known. Inhomogeneities in target materials. CH<sub>2</sub> is a polymer. C is crystalline. Polymer chains need not be randomly aligned.
- Sources not yet thought of !

## **Conclusion**

Not taking data on a liquid hydrogen target will severely affect the physics potential of MIPP, as well as hamper its ability to quickly debug its physics algorithms.

## APPENDIX A

### *p<sup>+</sup>p exclusive reactions*

- [PI+ P --> 2KS PI0 N](#)
- [PI+ P --> 2P PBAR 2PI+ PI-](#)
- [PI+ P --> 2P PBAR PI+](#)
- [PI+ P --> A1\(1270\)+ P](#)
- [PI+ P --> A2\(1320\)+ P](#)
- [PI+ P --> A4\(2040\)+ P](#)
- [PI+ P --> A6\(2450\)+ P](#)
- [PI+ P --> B1\(1235\)+ P](#)
- [PI+ P --> D P F1\(1285\) P](#)
- [PI+ P --> D P F1\(1420\) P](#)
- [PI+ P --> DD < 2PI+ PI- > P](#)
- [PI+ P --> DD < K+ K- PI+ > P](#)
- [PI+ P --> DD < P PI+ PI- > PI+](#)
- [PI+ P --> DD DD](#)
- [PI+ P --> DD P](#)
- [PI+ P --> DELTA\(1232P33\)+ BARYONIUM](#)
- [PI+ P --> DELTA\(1232P33\)+ PI+](#)
- [PI+ P --> DELTA\(1232P33\)+ PI+ PI0](#)
- [PI+ P --> DELTA\(1232P33\)++ 2PI0](#)
- [PI+ P --> DELTA\(1232P33\)++ < P PI+ > F2\(1270\) < PI+ PI- >](#)
- [PI+ P --> DELTA\(1232P33\)++ < P PI+ > PI+ PI-](#)
- [PI+ P --> DELTA\(1232P33\)++ < P PI+ > RHO0 < PI+ PI- >](#)
- [PI+ P --> DELTA\(1232P33\)++ F2\(1270\)](#)
- [PI+ P --> DELTA\(1232P33\)++ OMEGA](#)
- [PI+ P --> DELTA\(1232P33\)++ PI0](#)
- [PI+ P --> DELTA\(1232P33\)++ PI0 PI0](#)
- [PI+ P --> DELTA\(1232P33\)++ RHO0](#)
- [PI+ P --> DELTA\(1232P33\)++ RHO3\(1690\)0](#)
- [PI+ P --> ETA\(1440\) N](#)
- [PI+ P --> F2\(1270\) DELTA\(1232P33\)++](#)
- [PI+ P --> F4\(2030\) DELTA\(1232P33\)++](#)
- [PI+ P --> K\\*\(892\)+ SIGMA\(1385P13\)+](#)
- [PI+ P --> K\\*\(892\)+ SIGMA+](#)
- [PI+ P --> K+ K- DELTA\(1232P33\)++](#)
- [PI+ P --> K+ K- PI+ P](#)
- [PI+ P --> K+ PI+ K- P](#)
- [PI+ P --> K+ SIGMA\(1385P13\)+](#)
- [PI+ P --> K+ SIGMA+](#)
- [PI+ P --> KS KS PI0 N](#)

- $\text{PI}^+ \text{P} \rightarrow \text{LAMBDA K}^+ 2\text{PI}^+ \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{LAMBDA K}^+ \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{LAMBDA K}^+ \text{PI}^+ \text{PI}0$
- $\text{PI}^+ \text{P} \rightarrow \text{LAMBDA K}0 2\text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{LAMBDA K}0 2\text{PI}^+ \text{PI}0$
- $\text{PI}^+ \text{P} \rightarrow \text{N 2PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{N K}^+ \text{K}\bar{\text{B}}\text{AR0 PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{N K}0 \text{K}\bar{\text{B}}\text{AR0 2PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P 2PI}^+ \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{P 3PI}^+ 2\text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{P 4PI}^+ 3\text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{P 5PI}^+ 4\text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{P F2(1270) < PI}^+ \text{PI}^- > \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P F2(1270) PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}^+ \text{K}^- 2\text{PI}^+ \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}^+ \text{K}^- \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}^+ \text{K}\bar{\text{B}}\text{AR0}$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}^+ \text{K}\bar{\text{B}}\text{AR0 PI}^+ \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}^+ \text{K}\bar{\text{B}}\text{AR0 PI}0$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}0 \text{K}^- 2\text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}0 \text{K}\bar{\text{B}}\text{AR0 PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P K}0 \text{K}\bar{\text{B}}\text{AR0 PI}+ \text{PI}0$
- $\text{PI}^+ \text{P} \rightarrow \text{P LAMBDA LAMBDA B AR P}$
- $\text{PI}^+ \text{P} \rightarrow \text{P P P}\bar{\text{B}}\text{AR 2PI}^+ 2\text{PI}^- \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{P P P}\bar{\text{B}}\text{AR P}$
- $\text{PI}^+ \text{P} \rightarrow \text{P P P}\bar{\text{B}}\text{AR PI}^+ \text{PI}^- \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{P PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P PI}^+ \text{PI}0$
- $\text{PI}^+ \text{P} \rightarrow \text{P PI}0 \text{RHO}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P RHO}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P RHO}0 < \text{PI}^+ \text{PI}^- > \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P RHO}0 \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{P RHO}3(1690)0 \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{PHI DELTA}(1232\text{P}33)++$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ 2\text{K}^+ 2\text{K}^- \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ 2\text{PHI P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{DD}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{DELTA}(1232\text{P}33)+$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{F1}(1420) \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{K}^+ \text{K}^- \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{K}^+ \text{K}^- \text{PI}^+ \text{PI}^- \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{K}0 \text{K}^+ \text{PI}^- \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{K}0 \text{K}^- \text{PI}^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{KS K}^+ \text{PI}^- \text{P}$

- $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{KS K- PI- P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{N RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P 2PI+ 2PI-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P DD}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P GAMMA}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P K+ K-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P K+ K- PI+ PI-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P OMEGA}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PBAR 2PI+ 2PI- P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PBAR P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PBAR PI+ PI- P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI+ PI- PI-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI+ PI- RHO-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI- OMEGA}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI- PI+ RHO-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI- PI- PI0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI- PI- RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI- PI0 RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ PI- RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI0 RHO-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI0 RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ RHO-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI+ RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI0 PI- RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI0 PI0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI0 PI0 RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P PI0 RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{P RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PHI K+ K- P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ N}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ N OMEGA}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ N PI+ RHO-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ N PI- RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ N PI0 RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ N RHO0}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ PI+ N RHO-}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ PI- N RHO+}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ PI- P}$
  - $\text{PI}^+ \text{P} \rightarrow \text{PI}^+ \text{PI+ PI0 N RHO0}$

- $\text{PI}^+ \text{P} \rightarrow \text{PI}^- \text{ LAMBDA LAMBDA BAR P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^0 \text{PI}^0 \text{ DELTA}(1232\text{P}33)++$
- $\text{PI}^+ \text{P} \rightarrow \text{PI}^2(1680)^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{PION P}$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}(1600)^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}^+ \text{ DELTA}(1232\text{P}33)+$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}3(1690)^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}3(1690)^0 \text{ DELTA}(122\text{P}33)++$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}5(2350)^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{RHO}7(2750)^+ \text{P}$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}(1385\text{P}13)^+ \text{K}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^+ \text{K}^+ \text{PI}^+ \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^+ \text{K}^+ \text{PI}^+ \text{PI}^0 \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^+ \text{K}^+ \text{PI}^0$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^+ \text{K}^0 \text{2PI}^+ \text{PI}^-$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^+ \text{K}^0 \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^+ \text{K}^0 \text{PI}^+ \text{PI}^0$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^- \text{K}^+ \text{2PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^- \text{K}^0 \text{3PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^0 \text{K}^+ \text{PI}^+$
- $\text{PI}^+ \text{P} \rightarrow \text{SIGMA}^0 \text{K}^0 \text{2PI}^+$

## APPENDIX B

### ***K<sup>+</sup>p exclusive reactions***

- $K^+ P \rightarrow 2P \text{ LAMBDA BAR}$
- $K^+ P \rightarrow 2P \text{ PBAR } K^+ \pi^+ \pi^-$
- $K^+ P \rightarrow DD < 2K^+ K^- > DD < \text{DELTA}(1232P33)++ \pi^+ \pi^- >$
- $K^+ P \rightarrow DD < 2K^+ K^- > DD < P \text{ RHO}0 >$
- $K^+ P \rightarrow DD < 2K^+ K^- \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < 2K^+ K^- \text{ RHO}0 > P$
- $K^+ P \rightarrow DD < 2P \text{ PBAR } \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < \text{DELTA}(1232P33)++ K^+ K^- \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < \text{DELTA}(1232P33)++ \pi^+ 2\pi^- > K^+$
- $K^+ P \rightarrow DD < \text{DELTA}(1232P33)++ \pi^- > DD < K^+ \pi^+ \pi^- >$
- $K^+ P \rightarrow DD < K^*(892)+ (\text{NEUTRALS}) > P$
- $K^+ P \rightarrow DD < K^*(892)+ \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^*(892)0 2\pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^*(892)0 K^+ K^- \pi^+ > P$
- $K^+ P \rightarrow DD < K^*(892)0 \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^*(892)0 \pi^+ \pi^- (\text{NEUTRALS}) > P$
- $K^+ P \rightarrow DD < K^*\text{BAR}(892)0 2K^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^+ 2\pi^+ 2\pi^- > P$
- $K^+ P \rightarrow DD < K^+ \text{ PHI} \pi^+ \pi^- >$
- $K^+ P \rightarrow DD < K^+ \text{ PHI} \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^+ \pi^+ \pi^- > DD < 2P \text{ PBAR} >$
- $K^+ P \rightarrow DD < K^+ \pi^+ \pi^- > DD < P K^+ K^- >$
- $K^+ P \rightarrow DD < K^+ \pi^+ \pi^- > DD < P \pi^+ \pi^- >$
- $K^+ P \rightarrow DD < K^+ \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^+ \pi^+ \pi^- > P + DD < P \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < K^+ \text{ RHO}0 \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < K^0 \text{ RHO}0 \pi^+ > P$
- $K^+ P \rightarrow DD < K^2*(1430)+ (\text{NEUTRALS}) > P$
- $K^+ P \rightarrow DD < K^2*(1430)0 \pi^+ \pi^- (\text{NEUTRALS}) > P$
- $K^+ P \rightarrow DD < P 2\pi^+ 2\pi^- > K^+$
- $K^+ P \rightarrow DD < P > DD < K^+ > \pi^+ \pi^-$
- $K^+ P \rightarrow DD < P K^*(892)0 K^- \pi^+ > K^+$
- $K^+ P \rightarrow DD < P K^*\text{BAR}(892)0 K^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < P K^+ K^- \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < P K^+ K^- \text{ RHO}0 > K^+$
- $K^+ P \rightarrow DD < P \text{ PBAR } K^+ \pi^+ \pi^- > P$
- $K^+ P \rightarrow DD < P \text{ PHI} \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < P \pi^+ \pi^- > DD < 2K^+ K^- >$

- $K^+ P \rightarrow DD < P \pi^+ \pi^- > DD < K^*(892)0 \pi^+ >$
- $K^+ P \rightarrow DD < P \pi^+ \pi^- > DD < K^+ \pi^+ \pi^- >$
- $K^+ P \rightarrow DD < P \pi^+ \pi^- > DD < K^+ \rho(770)0 >$
- $K^+ P \rightarrow DD < P \pi^+ \pi^- > DD < P \bar{p} K^+ >$
- $K^+ P \rightarrow DD < P \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD < P \rho(770)0 > DD < K^+ \pi^+ \pi^- >$
- $K^+ P \rightarrow DD < P \rho(770)0 > DD < K^+ \rho(770)0 >$
- $K^+ P \rightarrow DD < P \rho(770)0 \pi^+ \pi^- > K^+$
- $K^+ P \rightarrow DD \bar{D}$
- $K^+ P \rightarrow DD \pi$
- $K^+ P \rightarrow \Delta(1232)0^+ K^0 \pi^+$
- $K^+ P \rightarrow \Delta(1232)0^{++} 2K^+ K^- \pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} < P \pi^+ > K^+ \pi^+ 2\pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^*(892)0$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^+ 2\pi^+ 3\pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^+ 3\pi^+ 4\pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^+ \pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^0$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^0 2\pi^+ 2\pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^0 \pi^+ \pi^-$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^0 \pi^0$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^2*(1430)0$
- $K^+ P \rightarrow \Delta(1232)0^{++} K^*(892)0$
- $K^+ P \rightarrow \Delta(1950)0 K^+ \pi^+$
- $K^+ P \rightarrow \Delta(1950)0^{++} K^*(892)0$
- $K^+ P \rightarrow K^*(892)^+ \pi^+$
- $K^+ P \rightarrow K^*(892)^+ \pi^+ N$
- $K^+ P \rightarrow K^*(892)^+ \pi^0 \pi^+$
- $K^+ P \rightarrow K^*(892)0 \Delta(1232)0^{++}$
- $K^+ P \rightarrow K^*(892)0 P \pi^+$
- $K^+ P \rightarrow K^*(892)0 \pi^+ P$
- $K^+ P \rightarrow K^+ \bar{D}$
- $K^+ P \rightarrow K^+ \pi$
- $K^+ P \rightarrow K^+ \pi 2\pi^+ 2\pi^-$
- $K^+ P \rightarrow K^+ \pi \bar{D}$
- $K^+ P \rightarrow K^+ \pi K^+ K^-$
- $K^+ P \rightarrow K^+ \pi K^+ K^- \pi^+ \pi^-$
- $K^+ P \rightarrow K^+ \pi \bar{p}$
- $K^+ P \rightarrow K^+ \pi^- \Delta(1232)0^{++}$
- $K^+ P \rightarrow K^0 N \pi^+ \pi^+$
- $K^+ P \rightarrow K^0 \pi^+ \pi^- P$
- $K^+ P \rightarrow K^+ \pi^- \Delta(1232)0^{++}$

- $K^+ P \rightarrow K2^*(1430)^+ P$
- $K^+ P \rightarrow K2^*(1430)^0 \Delta(1232)^{++}$
- $K^+ P \rightarrow K2^*(1430)^0 P \pi^+$
- $K^+ P \rightarrow K2^*(1430)^0 \pi^+ \pi^-$
- $K^+ P \rightarrow K3^*(1780)^+ P$
- $K^+ P \rightarrow K4^*(2060)^+ P$
- $K^+ P \rightarrow \Lambda(1380)^0 K^+$
- $K^+ P \rightarrow N(1440)^0 K^+$
- $K^+ P \rightarrow N(1700)^0 K^+$
- $K^+ P \rightarrow P \bar{K}^+ K^- \pi^+ \pi^-$
- $K^+ P \rightarrow P K^*(892)^+$
- $K^+ P \rightarrow P K^*(892)^+ 2\pi^+ 2\pi^-$
- $K^+ P \rightarrow P K^*(892)^+ \pi^+ \pi^-$
- $K^+ P \rightarrow P K^*(892)^0 3\pi^+ 2\pi^-$
- $K^+ P \rightarrow P K^*(892)^0 4\pi^+ 3\pi^-$
- $K^+ P \rightarrow P K^*(892)^0 < K^+ \pi^- > 2\pi^+ \pi^-$
- $K^+ P \rightarrow P K^*(892)^0 K^+ K^- \pi^+$
- $K^+ P \rightarrow P K^*(892)^0 \pi^+$
- $K^+ P \rightarrow P K^* \bar{B}(892)^0 2K^+ \pi^-$
- $K^+ P \rightarrow P K^+$
- $K^+ P \rightarrow P K^+ 2\pi^+ 2\pi^-$
- $K^+ P \rightarrow P K^+ 3\pi^+ 3\pi^-$
- $K^+ P \rightarrow P K^+ 4\pi^+ 4\pi^-$
- $K^+ P \rightarrow P K^+ \phi \pi^+ \pi^-$
- $K^+ P \rightarrow P K^+ \pi^+ \pi^-$
- $K^+ P \rightarrow P K^+ \rho(770)^0 2\pi^+ 2\pi^-$
- $K^+ P \rightarrow P K^+ \rho(770)^0 3\pi^+ 3\pi^-$
- $K^+ P \rightarrow P K^+ \rho(770)^0 < \pi^+ \pi^- > \pi^+ \pi^-$
- $K^+ P \rightarrow P K^0 2\pi^+ \pi^-$
- $K^+ P \rightarrow P K^0 3\pi^+ 2\pi^-$
- $K^+ P \rightarrow P K^0 \pi^+$
- $K^+ P \rightarrow P K^0 \rho(770)^0 2\pi^+ \pi^-$
- $K^+ P \rightarrow P K^0 \rho(770)^0 \pi^+$
- $K^+ P \rightarrow P K2^*(1430)^+$
- $K^+ P \rightarrow P K2^*(1430)^+ 2\pi^+ 2\pi^-$
- $K^+ P \rightarrow P K2^*(1430)^+ \pi^+ \pi^-$
- $K^+ P \rightarrow P K2^*(1430)^0 < K^+ \pi^- > 2\pi^+ \pi^-$
- $K^+ P \rightarrow P K2^*(1430)^0 \pi^+$
- $K^+ P \rightarrow \phi K^+ P$
- $K^+ P \rightarrow \rho(770)^+ K^0 P$

## APPENDIX C

### ***p<sup>+</sup>p exclusive reactions***

- P P --> 2LAMBDA 2K+
- P P --> 2P
- P P --> 2P ETA
- P P --> 2P OMEGA
- P P --> 2P PI+ PI-
- P P --> 2P PI+ PI0 PI-
- P P --> DD < P PI+ PI- > P
- P P --> DD P
- P P --> DELTA(1232P33)++ DELTA(1232P33)0
- P P --> DELTA(1232P33)++ N
- P P --> DEUT P
- P P --> DEUT PI+
- P P --> DEUT PI+ PI0
- P P --> LAMBDA K+ P
- P P --> LAMBDA LAMBDABAR P P
- P P --> LAMBDA P K+
- P P --> LAMBDA PHI K+ P
- P P --> N DELTA(1232P33)++
- P P --> N DELTA(1232P33)++ PI+ PI-
- P P --> N DELTA(1232P33)0 2PI+
- P P --> N N 2PI+
- P P --> P 2K+ 2K- P
- P P --> P 2PHI P
- P P --> P 2PI+ 2PI- P
- P P --> P A1(1270)0 P
- P P --> P A2(1320)0 P
- P P --> P DD
- P P --> P DELTA(1232P33)+
- P P --> P DELTA(1232P33)+ PI+ PI-
- P P --> P DELTA(1232P33)++ PI-
- P P --> P DELTA(1232P33)++ PI0 PI-
- P P --> P DELTA(1232P33)- 2PI+
- P P --> P DELTA(1232P33)0 PI+
- P P --> P DELTA(1232P33)0 PI+ PI0
- P P --> P ETA P
- P P --> P ETA PI+ PI- P
- P P --> P ETAPRIME P
- P P --> P F1(1285) P

- P P --> P F1(1420) P
- P P --> P F2(1720) P
- P P --> P F2PRIME(1525) P
- P P --> P K\*(892)0 K\*BAR(892)0 P
- P P --> P K+ K- K+ K- P
- P P --> P K+ K- P
- P P --> P K+ K- PI+ PI- P
- P P --> P K0 K+ PI- P
- P P --> P K0 K- PI+ P
- P P --> P K0 KBAR0 P
- P P --> P KS K+ K- P
- P P --> P KS K+ PI- P
- P P --> P KS K- PI+ P
- P P --> P N 2PI+ PI-
- P P --> P N 3PI+ 2PI-
- P P --> P N 4PI+ 3PI-
- P P --> P N PI+
- P P --> P N PI+ PI+ PI-
- P P --> P N PI+ PI0
- P P --> P OMEGA P
- P P --> P P
- P P --> P P 2PI+ 2PI-
- P P --> P P 2PI+ 2PI- PI0
- P P --> P P 2PI0
- P P --> P P 3PI+ 3PI-
- P P --> P P 3PI+ 3PI- PI0
- P P --> P P F0(1400)
- P P --> P P F0(975)
- P P --> P P F2(1270)
- P P --> P P K+ K-
- P P --> P P K+ K- PI+ PI-
- P P --> P P PBAR P
- P P --> P P PBAR P PI+ PI-
- P P --> P P PI+ PI-
- P P --> P P PI+ PI- PI0S
- P P --> P P PI0
- P P --> P PHI K+ K- P
- P P --> P PHI PHI P
- P P --> P PI+ N
- P P --> P PI+ PI+ PI- PI- P
- P P --> P PI+ PI- GAMMA P
- P P --> P PI+ PI- P

- P P --> P PI+ PI- PI+ PI- P
- P P --> P PI+ PI- PI0 P
- P P --> P RHO0 RHO0 P
- P P --> PI+ DEUT

## APPENDIX D

### *p<sup>-</sup>p exclusive reactions*

- PI- P --> \$M(1446) N
- PI- P --> \$M(1635) N
- PI- P --> \$M(1701) N
- PI- P --> \$X(1640) N
- PI- P --> \$X(1740) N
- PI- P --> \$X(1750) N
- PI- P --> \$X(1810) N
- PI- P --> \$X(1910) N
- PI- P --> \$X(1920) N
- PI- P --> \$X(1960) N
- PI- P --> \$X0(1480) N
- PI- P --> 2ETA N
- PI- P --> 2GAMMA N
- PI- P --> 2KS N
- PI- P --> 2KS PI0 N
- PI- P --> 2PHI N
- PI- P --> 2PI+ 2PI- N
- PI- P --> 2PI- PI0 PI+ P
- PI- P --> 2PI0 N
- PI- P --> A1(1270) N
- PI- P --> A1(1270)- P
- PI- P --> A2(1320) N
- PI- P --> A2(1320)- P
- PI- P --> A2(1320)0 N
- PI- P --> A4(2040) P
- PI- P --> A4(2040)- P
- PI- P --> B1(1235)- P
- PI- P --> B1(1235)0
- PI- P --> DD P
- PI- P --> DD PI-
- PI- P --> DELTA(1232P33)+ PI-
- PI- P --> DELTA(1232P33)+ PI- + DELTA(1232P33)- PI+
- PI- P --> DELTA(1232P33)++ 2PI-
- PI- P --> DELTA(1232P33)++ PI- PI-
- PI- P --> DELTA(1232P33)++ PI0 2PI-
- PI- P --> DELTA(1232P33)++ RHO- PI-
- PI- P --> DELTA(1232P33)- PI+
- PI- P --> DELTA(1232P33)0 BARYONIUM

- [PI- P --> DELTA\(1232P33\)0 ETA](#)
- [PI- P --> DELTA\(1232P33\)0 PI+ PI-](#)
- [PI- P --> DELTA\(1232P33\)0 PI0](#)
- [PI- P --> ETA ETA N](#)
- [PI- P --> ETA ETAPRIME N](#)
- [PI- P --> ETA N](#)
- [PI- P --> ETA PI+ PI- N](#)
- [PI- P --> ETA RHO0 N](#)
- [PI- P --> ETA\(1440\) N](#)
- [PI- P --> ETA/C\(2980\) N](#)
- [PI- P --> ETAPRIME ETA N](#)
- [PI- P --> ETAPRIME N](#)
- [PI- P --> F0\(1300\) N](#)
- [PI- P --> F0\(1590\) N](#)
- [PI- P --> F1\(1285\) N](#)
- [PI- P --> F1\(1420\) N](#)
- [PI- P --> F2\(1270\) DELTA\(1232P33\)0](#)
- [PI- P --> F2\(1270\) N](#)
- [PI- P --> F2\(1270\) PI- P](#)
- [PI- P --> F2\(1410\) N](#)
- [PI- P --> F2\(1720\) N](#)
- [PI- P --> F2\(1810\) N](#)
- [PI- P --> F2PRIME\(1525\) N](#)
- [PI- P --> F4\(2030\) N](#)
- [PI- P --> F6\(2510\) N](#)
- [PI- P --> GLUEBALL N](#)
- [PI- P --> H1\(1190\) N](#)
- [PI- P --> K\\*\(892\)+ SIGMA\(1385P13\)-](#)
- [PI- P --> K\\*\(892\)+ SIGMA-](#)
- [PI- P --> K\\*\(892\)0 LAMBDA](#)
- [PI- P --> K\\*\(892\)0 LAMBDA\(1520D03\)](#)
- [PI- P --> K\\*\(892\)0 SIGMA\(1385P13\)-](#)
- [PI- P --> K\\*\(892\)0 SIGMA\(1385P13\)0](#)
- [PI- P --> K\\*\(892\)0 SIGMA0](#)
- [PI- P --> K+ K- PI- P](#)
- [PI- P --> K+ KBAR0 PI- N](#)
- [PI- P --> K+ KBAR0S PI- N](#)
- [PI- P --> K+ PI- PI0 LAMBDA](#)
- [PI- P --> K+ PI0 LAMBDA](#)
- [PI- P --> K+ SIGMA\(1385P13\)-](#)
- [PI- P --> K+ SIGMA\(1670D13\)-](#)
- [PI- P --> K+ SIGMA\(1915F15\)-](#)
- [PI- P --> K+ SIGMA-](#)
- [PI- P --> K0 K- P](#)

- [PI- P --> K0 K0 N](#)
- [PI- P --> K0 LAMBDA](#)
- [PI- P --> K0 SIGMA\(1385P13\)0](#)
- [PI- P --> K0 SIGMA0](#)
- [PI- P --> K1\(1280\) LAMBDA](#)
- [PI- P --> K1\(1280\)0 LAMBDA](#)
- [PI- P --> K1\(1400\)0 LAMBDA](#)
- [PI- P --> K2\\*\(1430\)0 LAMBDA](#)
- [PI- P --> K2\\*\(1430\)0 LAMBDA\(1520D03\)](#)
- [PI- P --> K2\\*\(1430\)0 SIGMA0](#)
- [PI- P --> LAMBDA K0](#)
- [PI- P --> N 2ETA](#)
- [PI- P --> N 2PI+ 2PI-](#)
- [PI- P --> N 2PIO](#)
- [PI- P --> N 3PI+ 3PI-](#)
- [PI- P --> N A2\(1320\)0](#)
- [PI- P --> N ETA](#)
- [PI- P --> N ETA PIO](#)
- [PI- P --> N ETA\(1275\)](#)
- [PI- P --> N ETA\(1440\)](#)
- [PI- P --> N ETAPRIME](#)
- [PI- P --> N ETAPRIME ETA](#)
- [PI- P --> N F0\(1300\)](#)
- [PI- P --> N F0\(1590\)](#)
- [PI- P --> N F1\(1285\)](#)
- [PI- P --> N F1\(1420\)](#)
- [PI- P --> N F2\(1270\)](#)
- [PI- P --> N F2PRIME\(1525\)](#)
- [PI- P --> N F4\(2030\)](#)
- [PI- P --> N K+ K- PIO](#)
- [PI- P --> N OMEGA](#)
- [PI- P --> N PHI PHI](#)
- [PI- P --> N PHI PIO](#)
- [PI- P --> N PI+ PI-](#)
- [PI- P --> N PI0](#)
- [PI- P --> N RHO0](#)
- [PI- P --> N RHO3\(1690\)0](#)
- [PI- P --> N X\(2220\)](#)
- [PI- P --> N\(1440B\)+ PI-](#)
- [PI- P --> N\(1440B\)0 PIO](#)
- [PI- P --> N\(1520B\)0 BARYONIUM](#)
- [PI- P --> N\(1520B\)0 PI+ PI-](#)
- [PI- P --> N\(1700B\)+ PI-](#)
- [PI- P --> N\(1700B\)0 PI+ PI-](#)

- $\pi^- p \rightarrow N(1700B)0 \pi^0$
- $\pi^- p \rightarrow N(2100B)^+ \pi^-$
- $\pi^- p \rightarrow \Omega\bar{\Omega} N$
- $\pi^- p \rightarrow \Omega\bar{\Omega} \Omega\bar{\Omega} N$
- $\pi^- p \rightarrow \Omega\bar{\Omega} \pi^0$
- $\pi^- p \rightarrow \Omega\bar{\Omega} \pi^0 N$
- $\pi^- p \rightarrow p \pi^+ \pi^+ \pi^-$
- $\pi^- p \rightarrow p \pi^+ \pi^0 \pi^-$
- $\pi^- p \rightarrow p A_1(1270)^-$
- $\pi^- p \rightarrow p A_2(1320)^-$
- $\pi^- p \rightarrow p B_1(1235)^-$
- $\pi^- p \rightarrow p \eta \pi^-$
- $\pi^- p \rightarrow p f_2(1270) \pi^-$
- $\pi^- p \rightarrow p \Omega\bar{\Omega} \pi^-$
- $\pi^- p \rightarrow p \pi^+ \pi^+$
- $\pi^- p \rightarrow p \pi^+ \pi^- \pi^-$
- $\pi^- p \rightarrow p \pi^+ \pi^0 \pi^-$
- $\pi^- p \rightarrow p \pi^-$
- $\pi^- p \rightarrow p \pi^0 \pi^-$
- $\pi^- p \rightarrow p \pi^2(1680)^-$
- $\pi^- p \rightarrow p \rho^-$
- $\pi^- p \rightarrow p \rho^- \pi^+ \pi^-$
- $\pi^- p \rightarrow p \rho^0 \pi^-$
- $\pi^- p \rightarrow p \rho^0 \pi^0 \pi^-$
- $\pi^- p \rightarrow p \rho^3(1690)^-$
- $\pi^- p \rightarrow \phi \phi N$
- $\pi^- p \rightarrow \phi \pi^0 N$
- $\pi^- p \rightarrow \pi^+ \pi^- p$
- $\pi^- p \rightarrow \pi^+ \pi^- \pi^0 p$
- $\pi^- p \rightarrow \pi^+ \Delta(1232P33)^-$
- $\pi^- p \rightarrow \pi^+ \pi^- N$
- $\pi^- p \rightarrow \pi^+ \pi^- \pi^0$
- $\pi^- p \rightarrow \pi^+ \pi^- \pi^0 N$
- $\pi^- p \rightarrow \pi^- D\bar{D}$
- $\pi^- p \rightarrow \pi^- \Delta(1232P33)^+$
- $\pi^- p \rightarrow \pi^- f_0(1590) p$
- $\pi^- p \rightarrow \pi^- N(1440B)^+$
- $\pi^- p \rightarrow \pi^- N(1700B)^+$
- $\pi^- p \rightarrow \pi^- p$
- $\pi^- p \rightarrow \pi^- p \pi^+ \pi^-$
- $\pi^- p \rightarrow \pi^- p \pi^+ \pi^-$
- $\pi^- p \rightarrow \pi^- p \pi^0$
- $\pi^- p \rightarrow \pi^- p \pi^+ N$
- $\pi^- p \rightarrow \pi^- p \pi^+ \pi^-$

- [PI- P --> PI- PI0 P](#)
- [PI- P --> PI0 ETA N](#)
- [PI- P --> PI0 N](#)
- [PI- P --> PI2\(1680\)- P](#)
- [PI- P --> PIPRIME\(1273\) P](#)
- [PI- P --> RHO\(1600\)- P](#)
- [PI- P --> RHO- P](#)
- [PI- P --> RHO0 DELTA\(1232P33\)0](#)
- [PI- P --> RHO0 N](#)
- [PI- P --> RHO0 N\(1520B\)0](#)
- [PI- P --> RHO0 N\(1700B\)0](#)
- [PI- P --> RHO0 P](#)
- [PI- P --> RHO0 PI- P](#)
- [PI- P --> RHO3\(1690\)- P](#)
- [PI- P --> RHO3\(1690\)0](#)
- [PI- P --> RHO3\(1690\)0 N](#)
- [PI- P --> RHO5\(2350\)- P](#)
- [PI- P --> SIGMA- K+](#)
- [PI- P --> SIGMA/C\(2450\)+ D\\*\(2010\)-](#)
- [PI- P --> SIGMA0 K0](#)
- [PI- P --> X\(1750\) N](#)
- [PI- P --> X\(2200\)](#)

## APPENDIX E

### *K<sup>-</sup>p exclusive reactions*

- K<sup>-</sup> P --> \$X(2220) LAMBDA
- K<sup>-</sup> P --> 2KS LAMBDA
- K<sup>-</sup> P --> 2P PBAR K<sup>-</sup>
- K<sup>-</sup> P --> 2PHI LAMBDA
- K<sup>-</sup> P --> 2PHI SIGMA0
- K<sup>-</sup> P --> A1(1270)+ SIGMA-
- K<sup>-</sup> P --> A1(1270)- SIGMA+
- K<sup>-</sup> P --> A1(1270)0 LAMBDA
- K<sup>-</sup> P --> A2(1320)+ SIGMA-
- K<sup>-</sup> P --> A2(1320)- SIGMA+
- K<sup>-</sup> P --> A2(1320)0 LAMBDA
- K<sup>-</sup> P --> A2(1320)0 SIGMA0
- K<sup>-</sup> P --> B1(1235)+ SIGMA(1385P13)-
- K<sup>-</sup> P --> B1(1235)- SIGMA(1385P13)+
- K<sup>-</sup> P --> DD < DELTA(1232P33)++ PI- > K<sup>-</sup>
- K<sup>-</sup> P --> DD < K<sup>\*</sup>BAR(892)0 PI- > P
- K<sup>-</sup> P --> DD < K<sup>-</sup> 2PI+ 2PI- > P
- K<sup>-</sup> P --> DD < K<sup>-</sup> PI+ PI- > P
- K<sup>-</sup> P --> DD < P 2PI+ 2PI- > K<sup>-</sup>
- K<sup>-</sup> P --> DD < P PI+ PI- > DD < K<sup>-</sup> PI+ PI- >
- K<sup>-</sup> P --> DD < P PI+ PI- > K<sup>-</sup>
- K<sup>-</sup> P --> DD P
- K<sup>-</sup> P --> DELTA(1232P33)++ < P PI+ > K<sup>-</sup> PI-
- K<sup>-</sup> P --> DELTA(1232P33)++ K<sup>-</sup> PI-
- K<sup>-</sup> P --> DELTA(1232P33)0 K<sup>-</sup> PI+
- K<sup>-</sup> P --> ETA LAMBDA
- K<sup>-</sup> P --> ETAPRIME LAMBDA
- K<sup>-</sup> P --> F1(1285) LAMBDA
- K<sup>-</sup> P --> F1(1285) SIGMA(1385P13)0
- K<sup>-</sup> P --> F1(1285) SIGMA0
- K<sup>-</sup> P --> F1(1420) LAMBDA
- K<sup>-</sup> P --> F1(1420) SIGMA(1385P13)0
- K<sup>-</sup> P --> F1(1420) SIGMA0
- K<sup>-</sup> P --> F1(1530) LAMBDA
- K<sup>-</sup> P --> F1(1530) SIGMA(1385P13)0
- K<sup>-</sup> P --> F1(1530) SIGMA0

- $K^- P \rightarrow F2(1270) LAMBDA$
- $K^- P \rightarrow F2(1270) SIGMA0$
- $K^- P \rightarrow F2PRIME(1525) LAMBDA$
- $K^- P \rightarrow F2PRIME(1525) SIGMA0$
- $K^- P \rightarrow K(1830)^- P$
- $K^- P \rightarrow K^*(1790) N$
- $K^- P \rightarrow K^*(892)^+ PI0 XI^-$
- $K^- P \rightarrow K^*(892)^+ XI(1530P13)^-$
- $K^- P \rightarrow K^*(892)^+ XI^-$
- $K^- P \rightarrow K^*(892)^- P$
- $K^- P \rightarrow K^*(892)0 N$
- $K^- P \rightarrow K^*(892)0 PI^+ XI^-$
- $K^- P \rightarrow K^*(892)0 XI(1530P13)^-$
- $K^- P \rightarrow K^*(892)0 XI(1530P13)0$
- $K^- P \rightarrow K^+ K^- LAMBDA$
- $K^- P \rightarrow K^+ XI(1530P13)^-$
- $K^- P \rightarrow K^+ XI(1630)^-$
- $K^- P \rightarrow K^+ XI(1680)^-$
- $K^- P \rightarrow K^+ XI(1820)^-$
- $K^- P \rightarrow K^+ XI(1940)^-$
- $K^- P \rightarrow K^+ XI(2030)^-$
- $K^- P \rightarrow K^+ XI(2120)^-$
- $K^- P \rightarrow K^+ XI(2250)^-$
- $K^- P \rightarrow K^+ XI(2370)^-$
- $K^- P \rightarrow K^+ XI(2500)^-$
- $K^- P \rightarrow K^+ XI^-$
- $K^- P \rightarrow K^- ETA P$
- $K^- P \rightarrow K^- K^+ LAMBDA$
- $K^- P \rightarrow K^- P$
- $K^- P \rightarrow K^- PHI P$
- $K^- P \rightarrow K^- PI^+ N$
- $K^- P \rightarrow K^- PI^+ PI^- PI0 P$
- $K^- P \rightarrow K0 XI(1530P13)0$
- $K^- P \rightarrow K0 XI(2370)0$
- $K^- P \rightarrow K0 XI0$
- $K^- P \rightarrow K1(1240-1400)^- P$
- $K^- P \rightarrow K1(1280)^- P$
- $K^- P \rightarrow K1(1400)0 N$
- $K^- P \rightarrow K1(1400)0 P$
- $K^- P \rightarrow K2(1770)^- P$
- $K^- P \rightarrow K2(1770)0 P$
- $K^- P \rightarrow K2^*(1430)^- P$
- $K^- P \rightarrow K2^*(1430)0 N$
- $K^- P \rightarrow K2^*(1430)0 P$

- K- P --> K2\*BAR(1430)0 N
- K- P --> K2BAR(2250)- P
- K- P --> K3\*(1780)- P
- K- P --> K3\*(1780)0 N
- K- P --> K3\*(1780)0 P
- K- P --> K4\*(2060)- P
- K- P --> K4\*(2060)0 N
- K- P --> K4\*(2060)0 P
- K- P --> K5\*(2380)0 N
- K- P --> KBAR0 DELTA(1232P33)0
- K- P --> KBAR0 N
- K- P --> KBAR0 N(1520D13)0
- K- P --> KBAR0 N(1535S11)0
- K- P --> KBAR0 N(1650S11)0
- K- P --> KBAR0 N(1675D15)0
- K- P --> KBAR0 N(1680F15)0
- K- P --> KBAR0 PI+ PI- N
- K- P --> KBAR0 PI+ PI- P
- K- P --> KBAR0 PI- P
- K- P --> KBAR0 PI- PI+ PI- P
- K- P --> KBAR0 PI- PI+ PI- PI0 P
- K- P --> KN(1800)- P
- K- P --> KS K+ PI- LAMBDA
- K- P --> KS K- PI+ LAMBDA
- K- P --> KS KS LAMBDA
- K- P --> LAMBDA 2PI+ 2PI-
- K- P --> LAMBDA 3PI+ 3PI-
- K- P --> LAMBDA BARYONIUM
- K- P --> LAMBDA F2PRIME(1525)
- K- P --> LAMBDA K0 K0 K- P --> LAMBDA K0 K0 PI+ PI-
- K- P --> LAMBDA K0 K0 PI+ PI+ PI- PI-
- K- P --> LAMBDA K0 K0 PI+ PI- PI0
- K- P --> LAMBDA K0 K0 PI0
- K- P --> LAMBDA PBAR P
- K- P --> LAMBDA PI+ PI-
- K- P --> N K- 2PI+ PI-
- K- P --> N K- 3PI+ 2PI-
- K- P --> N K- PI+
- K- P --> N KBAR0
- K- P --> N(1700B)0 K- PI+
- K- P --> OMEGA LAMBDA
- K- P --> OMEGA SIGMA0
- K- P --> OMEGA3(1670) LAMBDA
- K- P --> P K\*BAR(892)0 < K- PI+ > PI-

- $K^- P \rightarrow P K^* \bar{B}AR(892)0 \pi^-$
- $K^- P \rightarrow P K^+ 2K^-$
- $K^- P \rightarrow P K^-$
- $K^- P \rightarrow P K^- 2\pi^+ 2\pi^-$
- $K^- P \rightarrow P K^- 2\pi^+ \pi^0 2\pi^-$
- $K^- P \rightarrow P K^- 3\pi^+ 3\pi^-$
- $K^- P \rightarrow P K^- 4\pi^+ 4\pi^-$
- $K^- P \rightarrow P K^- BARYONIUM$
- $K^- P \rightarrow P K^- \bar{P}BAR P$
- $K^- P \rightarrow P K^- \phi < K^+ K^- >$
- $K^- P \rightarrow P K^- \pi^+ \pi^-$
- $K^- P \rightarrow P K^- \pi^+ \pi^0 \pi^-$
- $K^- P \rightarrow P K^- \pi^0$
- $K^- P \rightarrow P K^- \rho^0$
- $K^- P \rightarrow P K^* \bar{B}AR(1430)0 \pi^-$
- $K^- P \rightarrow P \bar{K}AR0 2\pi^+ 3\pi^-$
- $K^- P \rightarrow P \bar{K}AR0 2\pi^+ \pi^0 3\pi^-$
- $K^- P \rightarrow P \bar{K}AR0 \pi^+ 2\pi^-$
- $K^- P \rightarrow P \bar{K}AR0 \pi^+ \pi^0 2\pi^-$
- $K^- P \rightarrow P \bar{K}AR0 \pi^-$
- $K^- P \rightarrow P \bar{K}AR0 \pi^0 \pi^-$
- $K^- P \rightarrow P K^S 2\pi^+ 3\pi^-$
- $K^- P \rightarrow P K^S 3\pi^+ 4\pi^-$
- $K^- P \rightarrow P K^S 4\pi^+ 5\pi^-$
- $K^- P \rightarrow P K^S \pi^+ 2\pi^-$
- $K^- P \rightarrow P K^S \pi^-$
- $K^- P \rightarrow \phi K^+ K^- \Lambda M B D A$
- $K^- P \rightarrow \phi \Lambda M B D A$
- $K^- P \rightarrow \phi \Sigma(1385)0$
- $K^- P \rightarrow \phi \Sigma^0$
- $K^- P \rightarrow \phi J/\psi(1850) \Lambda M B D A$
- $K^- P \rightarrow \pi^+ K^0 \Xi(1530)0^-$
- $K^- P \rightarrow \pi^+ K^0 \Xi^-$
- $K^- P \rightarrow \pi^+ \pi^- K^+ \Xi^-$
- $K^- P \rightarrow \pi^+ \pi^- \Lambda M B D A$
- $K^- P \rightarrow \pi^+ \Sigma(1385)0^-$
- $K^- P \rightarrow \pi^+ \Sigma^-$
- $K^- P \rightarrow \pi^- K^+ \Xi(1530)0$
- $K^- P \rightarrow \pi^- \Sigma(1385)0^+$
- $K^- P \rightarrow \pi^- \Sigma(1480)0^+$
- $K^- P \rightarrow \pi^- \Sigma(1775)0^+$
- $K^- P \rightarrow \pi^- \Sigma^+$
- $K^- P \rightarrow \pi^0 K^+ \Xi^-$
- $K^- P \rightarrow \pi^0 \Lambda M B D A$

- $K^- P \rightarrow \pi^0 \pi^+ K^0 \bar{\Lambda}$
- $K^- P \rightarrow \rho^0 \pi^+ \sigma^-$
- $K^- P \rightarrow \rho^0 \pi^- \sigma(1385)^\pm$
- $K^- P \rightarrow \rho^0 \pi^- \sigma^\pm$
- $K^- P \rightarrow \rho^0 \Lambda$
- $K^- P \rightarrow \rho^0 \sigma^0$
- $K^- P \rightarrow \sigma^0 f_2(1525)$
- $K^- P \rightarrow \sigma^0 K^0 \bar{K}^0$
- $K^- P \rightarrow \bar{\Lambda}(2370)^- K^+ \pi^0$
- $K^- P \rightarrow \bar{\Lambda}(2370)^- K^0 \pi^+$
- $K^- P \rightarrow \bar{\Lambda}(2370)^0 K^+ \pi^-$
- $K^- P \rightarrow \bar{\Lambda}(2370)^0 K^0 \pi^0$
- $K^- P \rightarrow \bar{\Lambda}^- K^+ \pi^+ \pi^+ \pi^- \pi^-$
- $K^- P \rightarrow \bar{\Lambda}^- K^+ \pi^+ \pi^-$
- $K^- P \rightarrow \bar{\Lambda}^- K^+ \pi^+ \pi^- \pi^0$
- $K^- P \rightarrow \bar{\Lambda}^- K^+ \pi^0$
- $K^- P \rightarrow \bar{\Lambda}^- K^0 \pi^+$
- $K^- P \rightarrow \bar{\Lambda}^- K^0 \pi^+ \pi^+ \pi^- \pi^- \pi^0$
- $K^- P \rightarrow \bar{\Lambda}^- K^0 \pi^+ \pi^+ \pi^-$
- $K^- P \rightarrow \bar{\Lambda}^- K^0 \pi^+ \pi^- \pi^0$
- $K^- P \rightarrow Y^*(1420) \pi^0$
- $K^- P \rightarrow Y^*(1420) K^+ K^- \pi^0$

## APPENDIX F

### *p̄p exclusive reactions*

- [PBAR P --> 2DD](#)
- [PBAR P --> 2KS 2PI+ 2PI-](#)
- [PBAR P --> 2KS 3PI+ 3PI-](#)
- [PBAR P --> 2KS PI+ PI-](#)
- [PBAR P --> 2P 2PBAR](#)
- [PBAR P --> 2P 2PBAR PI+ PI-](#)
- [PBAR P --> 2PHI](#)
- [PBAR P --> 2PI+ 2PI-](#)
- [PBAR P --> 2PI+ 2PI- PI0](#)
- [PBAR P --> 2PI+ PI0 2PI-](#)
- [PBAR P --> 2PI0](#)
- [PBAR P --> 3PI+ 3PI-](#)
- [PBAR P --> 3PI+ 3PI- PI0](#)
- [PBAR P --> 3PI+ PI0 3PI-](#)
- [PBAR P --> 4PI+ 4PI-](#)
- [PBAR P --> 4PI+ 4PI- PI0](#)
- [PBAR P --> 4PI+ PI0 4PI-](#)
- [PBAR P --> 5PI+ 5PI-](#)
- [PBAR P --> 5PI+ 5PI- PI0](#)
- [PBAR P --> 5PI+ PI0 5PI-](#)
- [PBAR P --> 6PI+ 6PI-](#)
- [PBAR P --> 6PI+ PI0 6PI-](#)
- [PBAR P --> 7PI+ 7PI-](#)
- [PBAR P --> A2\(1320\)- PI+](#)
- [PBAR P --> A2\(1320\)- RHO+](#)
- [PBAR P --> A2\(1320\)0 PI+ PI-](#)
- [PBAR P --> ANNIHIL](#)
- [PBAR P --> DD < DELTA\(1232P33\)++ PI- > DD <](#)
- [PBAR P --> DD < P 2PI+ 2PI- > PBAR](#)
- [PBAR P --> DD < P 2RHO0 > PBAR](#)
- [PBAR P --> DD < P PI+ PI- > DD < PBAR PI+ PI- >](#)
- [PBAR P --> DD < P PI+ PI- > PBAR](#)
- [PBAR P --> DD < P RHO0 PI+ PI- > PBAR](#)
- [PBAR P --> DD < PBAR PI+ PI- > P](#)
- [PBAR P --> DD < PBAR PI+ PI- > P + DD < P PI+ PI- > PBAR](#)
- [PBAR P --> DD P](#)
- [PBAR P --> DD PBAR](#)
- [PBAR P --> DELTABAR\(1232P33\)-- DELTA\(1232P33\)++](#)

- [PBAR P --> ETA A2\(1320\)0](#)
- [PBAR P --> ETA OMEGA](#)
- [PBAR P --> ETA PI0](#)
- [PBAR P --> ETA RHO0](#)
- [PBAR P --> ETA/C\(2980\)](#)
- [PBAR P --> ETAPRIME GAMMA](#)
- [PBAR P --> ETAPRIME PI0](#)
- [PBAR P --> F2\(1270\) PI+ PI-](#)
- [PBAR P --> K\\*\(892\)- K\\*\(892\)+](#)
- [PBAR P --> K\\*\(892\)- K+](#)
- [PBAR P --> K\\*\(892\)0 K\\*BAR\(892\)0](#)
- [PBAR P --> K\\*\(892\)0 K+ PI-](#)
- [PBAR P --> K\\*\(892\)0 K- PI+](#)
- [PBAR P --> K\\*BAR\(892\)0 K\\*\(892\)0](#)
- [PBAR P --> K\\*BAR\(892\)0 K+ PI-](#)
- [PBAR P --> K+ K-](#)
- [PBAR P --> K+ K- 2PI+ 2PI-](#)
- [PBAR P --> K+ K- 3PI+ 3PI-](#)
- [PBAR P --> K+ K- 4PI+ 4PI-](#)
- [PBAR P --> K+ K- PI+ PI-](#)
- [PBAR P --> K+ K- RHO0](#)
- [PBAR P --> K+ KBAR0 2PI+ 3PI-](#)
- [PBAR P --> K+ KBAR0 3PI+ 4PI-](#)
- [PBAR P --> K+ KBAR0 4PI+ 5PI-](#)
- [PBAR P --> K+ KBAR0 PI+ 2PI-](#)
- [PBAR P --> K- K\\*\(892\)+](#)
- [PBAR P --> K- K+](#)
- [PBAR P --> K- K2\\*\(1430\)+](#)
- [PBAR P --> K0 K- 2PI+ PI-](#)
- [PBAR P --> K0 K- 3PI+ 2PI-](#)
- [PBAR P --> K0 K- 4PI+ 3PI-](#)
- [PBAR P --> K0 K- 5PI+ 4PI-](#)
- [PBAR P --> K2\\*\(1430\)- K+](#)
- [PBAR P --> K2\\*\(1430\)0 K+ PI-](#)
- [PBAR P --> K2\\*\(1430\)0 K- PI+](#)
- [PBAR P --> K2\\*BAR\(1430\)0 K+ PI-](#)
- [PBAR P --> KS K\\*\(892\)0](#)
- [PBAR P --> KS K+ PI-](#)
- [PBAR P --> KS K+ PI- 2PI+ 2PI-](#)
- [PBAR P --> KS K+ PI- 3PI+ 3PI-](#)
- [PBAR P --> KS K+ PI- 4PI+ 4PI-](#)
- [PBAR P --> KS K+ PI- PI+ PI-](#)
- [PBAR P --> KS K- PI+](#)
- [PBAR P --> KS K- PI+ 2PI+ 2PI-](#)

- PBAR P --> KS K- PI+ 3PI+ 3PI-
- PBAR P --> KS K- PI+ 4PI+ 4PI-
- PBAR P --> KS K- PI+ PI+ PI-
- PBAR P --> KS K2\*(1430)0
- PBAR P --> KS KL
- PBAR P --> LAMBDA LAMBDA BAR 2PI+ 2PI-
- PBAR P --> LAMBDA LAMBDA BAR 3PI+ 3PI-
- PBAR P --> LAMBDA LAMBDA BAR PI+ PI-
- PBAR P --> LAMBDA SIGMA BAR 0
- PBAR P --> LAMBDA BAR LAMBDA
- PBAR P --> LAMBDA BAR SIGMA 0
- PBAR P --> NBAR DELTA(1232P33)0
- PBAR P --> NBAR P 3PI- 2PI+
- PBAR P --> NBAR P 4PI- 3PI+
- PBAR P --> NBAR P PI-
- PBAR P --> NBAR P PI- PI- PI+
- PBAR P --> OMEGA GAMMA
- PBAR P --> OMEGA NNBAR(1935)
- PBAR P --> OMEGA NNBAR(2020)
- PBAR P --> OMEGA NNBAR(2200)
- PBAR P --> OMEGA NNBAR(2950)
- PBAR P --> OMEGA PI0
- PBAR P --> P DELTA BAR(1232P33)-- PI+
- PBAR P --> P DELTA BAR(1232P33)-- PI+ PI0
- PBAR P --> P DELTA BAR(1232P33)0 PI-
- PBAR P --> P DELTA BAR(1950B)-- PI+
- PBAR P --> P NBAR PI-
- PBAR P --> P PBAR
- PBAR P --> P PBAR 2PI+ 2PI-
- PBAR P --> P PBAR 3PI+ 3PI-
- PBAR P --> P PBAR 4PI+ 4PI-
- PBAR P --> P PBAR 5PI+ 5PI-
- PBAR P --> P PBAR 6PI+ 6PI-
- PBAR P --> P PBAR K+ K-
- PBAR P --> P PBAR K+ K BAR 0 2PI+ 3PI-
- PBAR P --> P PBAR K+ K BAR 0 3PI+ 4PI-
- PBAR P --> P PBAR K+ K BAR 0 PI+ 2PI-
- PBAR P --> P PBAR K+ K BAR 0 PI-
- PBAR P --> P PBAR K0 K- 2PI+ PI-
- PBAR P --> P PBAR K0 K- 3PI+ 2PI-
- PBAR P --> P PBAR K0 K- 4PI+ 3PI-
- PBAR P --> P PBAR K0 K- PI+
- PBAR P --> P PBAR K0 K BAR 0
- PBAR P --> P PBAR K0 K BAR 0 2PI+ 2PI-

- PBAR P --> P PBAR K0 KBAR0 PI+ PI-
- PBAR P --> P PBAR OMEGA
- PBAR P --> P PBAR PI+ PI-
- PBAR P --> P PBAR PI+ PI0 PI-
- PBAR P --> P PBAR PI0
- PBAR P --> P PBAR RHO+ PI-
- PBAR P --> P PBAR RHO- PI+
- PBAR P --> PBAR DELTA(1232P33)+
- PBAR P --> PBAR DELTA(1232P33)++ PI-
- PBAR P --> PBAR DELTA(1232P33)++ PI0 PI-
- PBAR P --> PBAR DELTA(1232P33)0 PI+
- PBAR P --> PBAR DELTA(1950B)++ PI-
- PBAR P --> PBAR LAMBDA K+
- PBAR P --> PBAR LAMBDA K+ 2PI+ 2PI-
- PBAR P --> PBAR LAMBDA K+ 3PI+ 3PI-
- PBAR P --> PBAR LAMBDA K+ PI+ PI-
- PBAR P --> PBAR LAMBDA K0 2PI+ PI-
- PBAR P --> PBAR LAMBDA K0 3PI+ 2PI-
- PBAR P --> PBAR LAMBDA K0 PI+
- PBAR P --> PBAR N 3PI+ 2PI-
- PBAR P --> PBAR N 4PI+ 3PI-
- PBAR P --> PBAR N PI+
- PBAR P --> PBAR N PI+ PI+ PI-
- PBAR P --> PBAR P
- PBAR P --> PBAR P 2PI+ 2PI-
- PBAR P --> PBAR P 2PI+ 2PI- PI0
- PBAR P --> PBAR P 3PI+ 3PI-
- PBAR P --> PBAR P 3PI+ 3PI- PI0
- PBAR P --> PBAR P 4PI+ 4PI-
- PBAR P --> PBAR P PI+ PI+ PI- PI-
- PBAR P --> PBAR P PI+ PI-
- PBAR P --> PBAR P PI+ PI- PI0
- PBAR P --> PBAR P PI0
- PBAR P --> PBAR P PI0 PBAR P --> PBAR N PI+
- PBAR P --> PBAR PI+ P PI-
- PBAR P --> PHI GAMMA
- PBAR P --> PHI PHI
- PBAR P --> PHI PI+ PI-
- PBAR P --> PHI PI0
- PBAR P --> PHI RHO0
- PBAR P --> PI+ PI-
- PBAR P --> PI+ PI- PI0
- PBAR P --> PI- A2(1320)+
- PBAR P --> PI- PI+

- [PBAR P --> PI0 ETA](#)
- [PBAR P --> PI0 ETAPRIME](#)
- [PBAR P --> PI0 F0\(975\)](#)
- [PBAR P --> PI0 F1\(1285\)](#)
- [PBAR P --> PI0 F1\(1420\)](#)
- [PBAR P --> PI0 F2PRIME\(1525\)](#)
- [PBAR P --> PI0 GAMMA](#)
- [PBAR P --> PI0 OMEGA](#)
- [PBAR P --> PI0 PHI](#)
- [PBAR P --> PI0 PI0](#)
- [PBAR P --> PI0 RHO0](#)
- [PBAR P --> RHO- A2\(1320\)+](#)
- [PBAR P --> RHO0 F0\(975\)](#)
- [PBAR P --> RHO0 F1\(1285\)](#)
- [PBAR P --> RHO0 K+ K-](#)
- [PBAR P --> RHO0 OMEGA](#)
- [PBAR P --> RHO0 PHI](#)
- [PBAR P --> RHO0 PI0](#)